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SMALL-SCALE HYDROELECTRIC POTENTIAL OF THE MILL DIVERSION CHANNEL IN LEWISTOWN, MONTANA

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SMALL-SCALE HYDROELECTRIC POTENTIAL OF THE MILL DIVERSION CHANNEL IN LEWISTOWN, MONTANA

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May 1985

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EXECUTIVE SUMMARY

Project Description

The general study area is the Mill Diversion Channel (MDC) in Lewistown, Montana, shown in plan view in Figure 1. The drainage system that determines flow into the MDC system originates in the mountains 21 miles to the south of Lewistown, with the primary flow being from the spring called Big Spring. Water usage within the Big Spring Creek watershed is primarily for livestock and domestic use, including the water supply for Lewistown. Other uses include a Montana State fishery, a small amount of irrigation, and the U.S. Gypsum Company's plant near Heath, Montana.

The course of the MDC, detailed in Figure 2, is adjacent to a railroad spur on the east side of Lewistown. The length of the channel is approximately 0.6 mile, and it is built of concrete. The MDC takes about three-quarters of the available flow in the Big Spring Creek from the mouth of the channel southeast of the town and returns at the flow of the north edge of town.

The primary site for locating the turbine generator facilities is within the town, approximately one hundred yards northeast of the Yogo Inn. This site and the MDC are owned and maintained by the City of Lewistown.

To evaluate the potential power producing capability of the MDC, various types of data are required. The primary information needed is water flow, preferably over a long period of time. Fortunately, data were available from several sources.

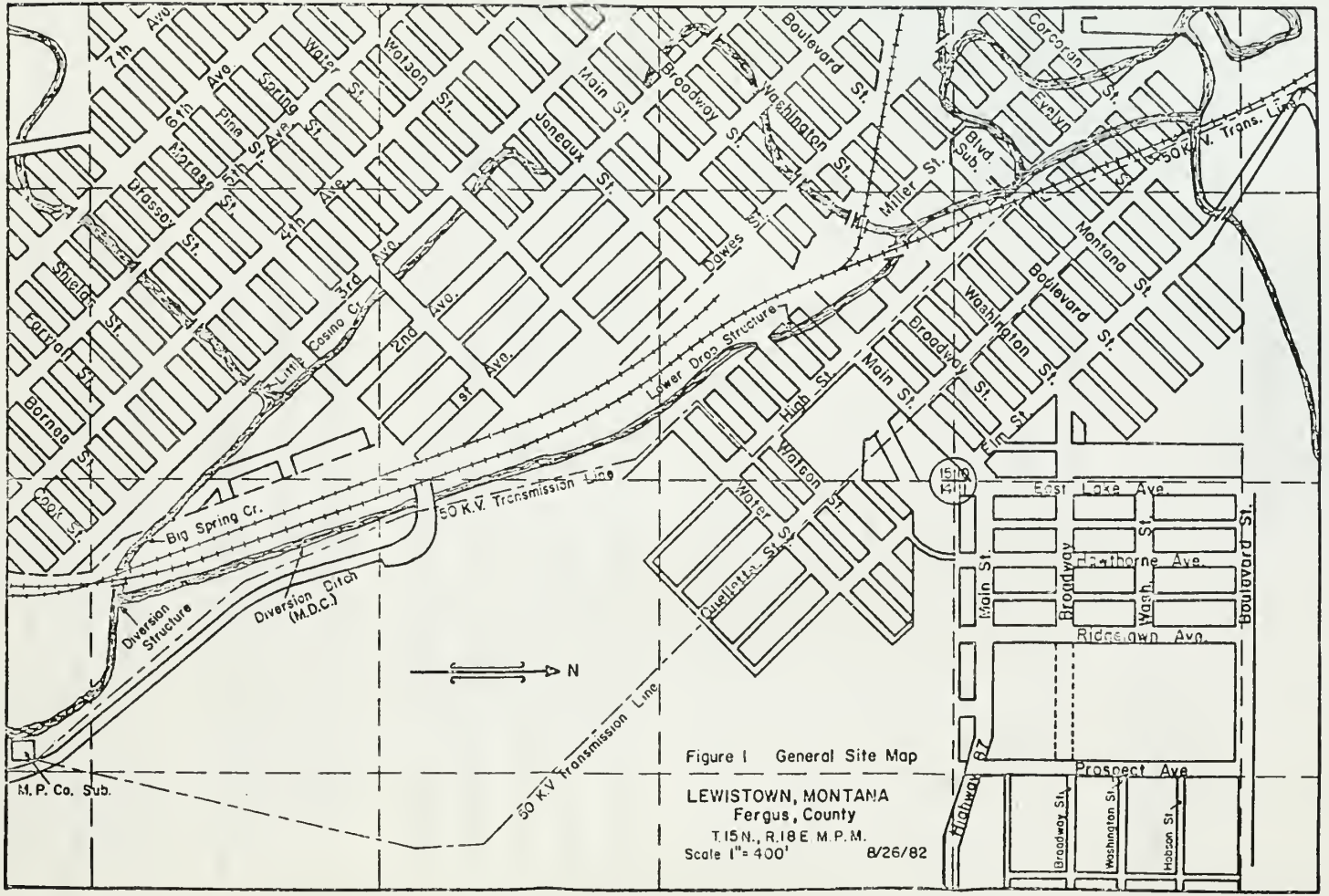


Figure 1 General Site Map

LEWISTOWN, MONTANA
Fergus, County
T.15N., R.18E. M.P.M.
Scale 1"= 400' 8/26/82

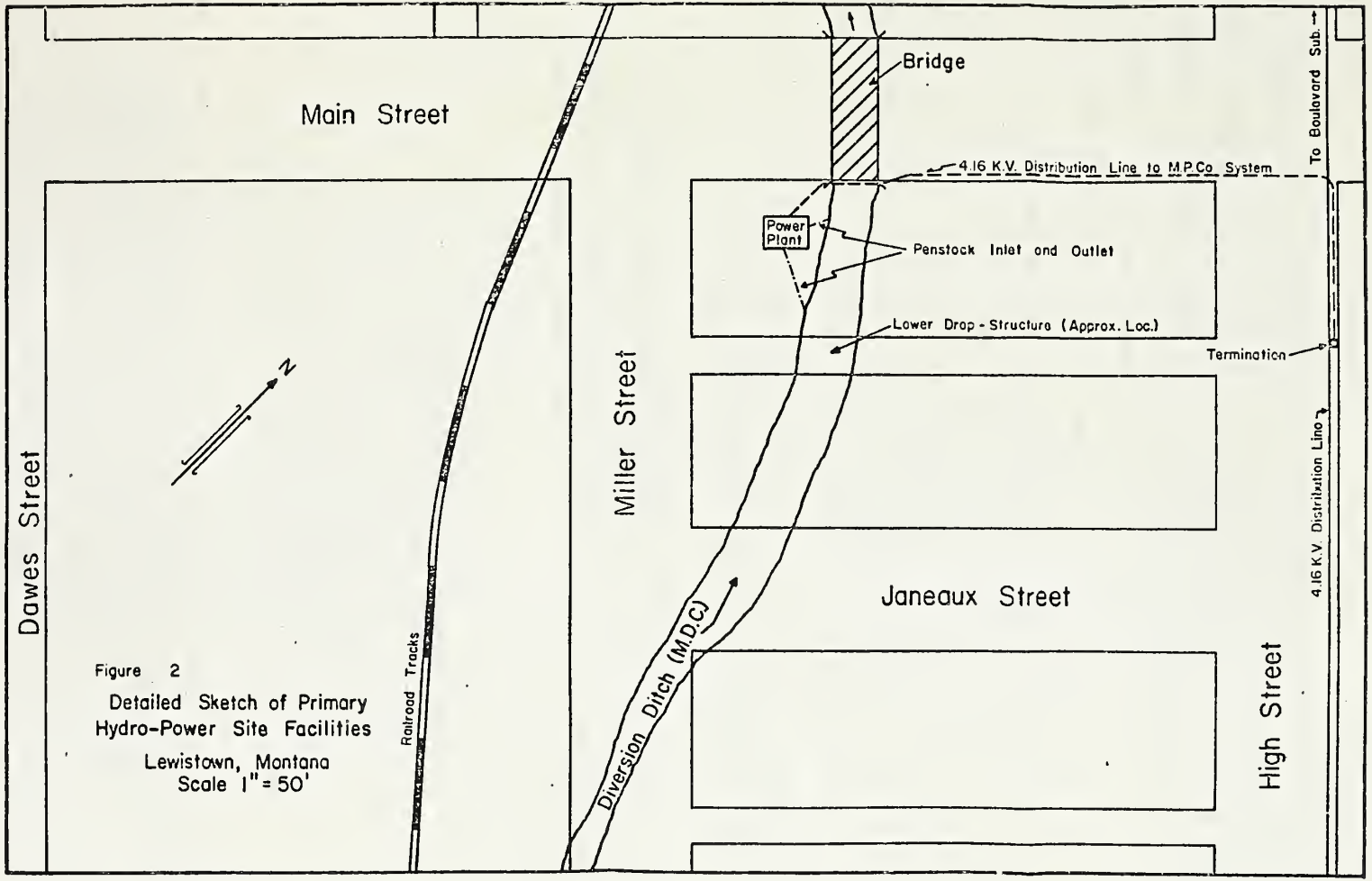


Figure 2

Detailed Sketch of Primary Hydro-Power Site Facilities

Lewistown, Montana
Scale 1" = 50'

Measurements of water flow into the MDC-Big Spring Creek Diversion structure have been recorded upstream at the Ash Street Bridge. Data also were available from three main sources of that flow - Big Spring, East Fork Reservoir, and the East Fork of Big Spring. Statistical comparison showed that flow changes in Big Spring Creek follow the changes in the three main sources; this good correlation of the four data sources lends credence and acceptability of the data available from those sources. Once the Ash Street Bridge data were determined to be usable, a hydrograph was prepared. An average maximum of approximately 345 cubic feet per second (cfs) occurs when using data gathered over a 30+-year period. As expected, peak flow occurs in the spring (May/June) time period. Minimum flow is maintained at about 170 cfs due largely to the relatively constant flow from Big Spring (90 to 123 cfs).

A flow duration curve was calculated from day-to-day readings at the Ash Street Bridge for 1977 through 1982. Significant waterflow quantities can be derived from the curve:

1. Annual average is 222.2 $\pm$ 76.6 cfs.
2. Less than 160 cfs, 20% of the time.
3. 160 to 200 cfs, 53% of the time.
4. Greater than 200 cfs, 27% of the time.

Approximately three-quarters of the above flow is presently diverted down the MDC, and therefore is available for power production unless upstream management practices are changed. Regardless, some open stream flow must be maintained for fish migration in both channels. This was a basic assumption used to obtain flow available for power production. A thorough literature

review as well as conversations with knowledgeable individuals indicated that approximately 37 cfs would be required in the natural channel and 15 cfs would be sufficient in the MDC (including fish ladders) for fish movement. The total flow of 52 cfs is about 23 percent of the average flow available to the two streams.

Flow leveling through discharge management of upstream retaining structures could increase the generating capacity factor. However, this concept would require recognition of the rights of downstream water users as well as the requirements of the managers of the retention structures.

Present electricity supply for the Lewistown area is from the MPC system and furnished by Central Montana Generation and Transmission Cooperative, Inc. to Fergus Electric Cooperative (FEC) for their distribution. Electricity demand in the area is primarily for residential and agricultural use. In fact, residential consumers account for 75% of all kWh sales. Demand growth is just over 1% per year, with a total of approximately 103 million kWh to be purchased by Fergus Electric Cooperative by 1987. Nearly one-third of this power (about 34 million kWh) would be used in the immediate vicinity of Lewistown. As the MDC hydropower project would produce 1.2 million kWh, or about 3.6% of the power available near Lewistown, the system of Fergus Electric Cooperative is capable of absorbing the hydro-produced power.

The original proposed design for this project was found to be uneconomical. It basically entailed installing a pipeline (penstock) in the Mill Diversion Channel from the upper drop structure to just past the lower drop structure, with a turbine placed at the end of the penstock. Major obstacles included

the expense of the long penstock (i.e., 3500 feet of 90-inch pipe) and the excessive head losses, resulting in lower energy figures than anticipated. This study was suspended after these findings became apparent.

A different approach to the design was developed by MultiTech personnel and presented to FEC and the Montana Department of Natural Resources and Conservation (DNRC). This design consisted of allowing the water to flow in the MDC and installing a gate across the channel just above the lower drop structure. The gate would act as a small dam, with a water depth of 8 feet behind it, tapering to 2 feet at the upstream end (the upper drop structure). The turbine would be placed in the center of the channel, just below the existing drop-off. This improved the economic outlook of the project considerably by eliminating the cost of the long penstock and by enhancing the net head value (from 10 to 15 feet).

However, another obstacle was encountered: flood control. The SCS is responsible for the flow distribution of the Big Spring Creek drainage. Upon being presented with the design, the main concerns were that no permanent obstructions be placed in the channel and that any gate installed must be fail-safe. In a meeting with the SCS, an alternative was proposed. If the turbine could be moved to the side of the channel, with a fail-safe gate only installed across the channel, the design would be acceptable to the SCS.

Another meeting in Lewistown in April 1984 clarified one more design consideration: fish passage in the MDC/Big Spring Creek system. The present channel prevents the majority of fish passage at two points: the drop structure (approximate height of 10 feet) and the headgate that directs water into the

MDC. All the initial parties to the feasibility study - FEC, the City of Lewistown, and MultiTech - saw the hydropower development project as a practical means of providing for fish passage upstream, thereby greatly enhancing local fishery potential. The method selected is to install fish ladders at the drop structure, which coincides with the gate placement for hydropower purposes; another fish ladder around the MDC headgate; and a ditch or pipe around the headgate on Big Spring Creek.

This report presents the proposed ("final") design, already agreed to in concept by the district and regional offices of the SCS. The main objective is to make the project economically attractive by minimizing capital costs and maximizing power produced, while staying within the flood control and and fisheries criteria. Within these constraints, the project can generate 1,243,616 kWh annually from a Kaplan turbine sized for a maximum flow of 237 cfs.

Implementation of this feasibility study is defined in three phases of the project: Economics, Permitting, and Design/Construction. Keys to economic considerations are the price to be paid for the power generated and the type of financing available. Finalization of both considerations will depend on the PSC's ruling based on avoided-cost rate hearings starting in May 1985. Permitting and other regulatory procedures do not appear to be particularly troublesome for this project, although sufficient time must be allowed for the mandatory interfaces with Federal and State agencies and the public. Both the economic and permitting activities should begin immediately to allow sufficient time for consideration of economic options and for prioritizing claims for the project with permitting agencies.

The initiation of Design/Construction activities is dependent on the timely decisions of the PSC and financing sources; however, with the assumptions of a PSC decision by September 1985 and financing arrangements concluded by October 1985, the facility design could start by February 1986, equipment ordered by March, construction started in July, thereby leading to a November 1986 acceptance and operation of the facility by the City.

Economics

The Fergus Electric Cooperative, located in Lewistown, conceived and initiated the study of hydro power at the Mill Diversion Channel (MDC). The Coop did this with the enthusiastic concurrence of the operator of the MDC, the City of Lewistown. Operational responsibility of the present MDC was given to the City by the Soil Conservation Service (SCS), which constructed the flood control channel. Consequently, hydropower modifications to the MDC will have to have concurrence from the SCS and the State of Montana agencies, particularly the Fish, Wildlife, and Parks Department. Operational responsibility of the hydro and fish passage structures will be with the City. FEC would be contracted by the City to provide expertise as required for periodic maintenance, trouble-shooting, and electrical system maintenance. The City would make the contractual arrangements for the sale of the power.

The scenario outlined above shows that project interests and responsibilities will move from FEC to the City as this study nears conclusion. FEC will continue to be vitally interested and actively supportive, but financing discussions will necessarily center around avenues that the City has to obtain project financing.

An examination of financing alternatives provides the City of Lewistown with several choices. Among the alternatives that appear most attractive from availability and cost-of-money standpoints are 1) financing the project with taxpayer-backed general revenue bonds, and 2) obtaining a State Water Resources loan financed by sale of Coal Severence Tax Bonds. This combination could provide interest ranges significantly lower than other bonds.

Interest rate analysis indicated that a rise during early and mid-1985 will be followed by a two percentage point drop in 1986, with the net result of rates being close to today's rates of 9.5% to 10.5% for Baa rated municipal bonds.

Project costs are considered to range from $595,600 to $488,900 total capital investment, with operating and maintenance costs of $8,820 (escalating) per year.

Project benefits are derived from projected sale of power under the Montana Public Service Commission Orders 5017 and 5017A. Expected annual revenues (benefits) are estimated to average $88,740 per year. The revenue calculation was based on current avoided-cost rates for a fully levelized 35-year power sales contract.

Cash flow analysis, benefit/cost ratio (B/C ratio), and internal rate of return (IRR) were performed for a variety of interest rates for each of 15- and 20-year debt retirement terms. Earnings for the upper and lower project cost estimates are $652,406, or $56,806 in 20 years over the original investment of $595,600; and $587,995, or $99,095 in 15 years above the estimated

project investment of $488,900. The 15-year IRR for a project investment of $488,900 is 13.48% and the 20-year IRR for $595,600 is 11.41%. Both IRR's are substantially above the assumed interest rate of 10%, thereby making the MDC hydro project an economic investment.

Environmental

The primary objective of the environmental investigation was the evaluation of beneficial and adverse consequences arising from implementing the proposed hydropower development and fisheries enhancement schemes.

In general, project implementation will result in neutral-to-strongly beneficial socioeconomic consequences and short-term adverse effects on the natural environment. The former benefits will include employment opportunities and income via purchases of construction materials. Long-term benefits include revenues from sales of hydroelectric power and enhancement of the sport fisheries resource. Concerns regarding geoedaphic constraints and fish mortality from passing through the turbine can be mitigated largely by careful location, design, and operation of the various hydropower generation and fishway facilities. Therefore, this project should be viewed favorably, as benefits clearly outweigh the adverse consequences.

The impact assessments and generic mitigating measures should satisfy Preliminary Environmental Review (PER) requirements of the State of Montana. Furthermore, the compiled information will be adequate for completion of all anticipated permitting requirements, including the application for either

licensing or exemption from licensing to be submitted to the U.S. Federal Energy Regulatory Commission (FERC).

Legal Requirements

The procedures for acquiring the necessary licenses and/or permits from the pertinent federal, state, and local entities are presented, along with their respective review authority(ies), in this report and the Milestone 5 Report. Despite the relative ease of project compliance with these institutional expectations, the duration required for doing so can consume a substantial portion of the time allocated towards bringing a project "on-line". Thus, it is of great importance for the site developer to initiate the permitting process as early as possible within the overall project development schedule. Furthermore, contact with the pertinent regulatory personnel during these early stages of project development (and permit preparation) will aid in timely correction of perceived problems related to preliminary engineering design and analysis, site locations, etc. In this fashion, last-minute delays due to problems unforeseen by the developer can be largely avoided.

Existing water rights present a confusing picture because neither the summary of claims nor their determination is yet available. As the hydro project attains specific definition, additional clarification of water rights will result. A permit review hearing will be necessary and should resolve water rights questions.

Future development plans of the water in the Big Spring Creek system are not extensive at this time. The City of Lewistown is redefining a previous application that would allow for water to support increased municipal water use. Several dams exist upstream of the MDC that provide flood control and recreational uses. Additional dams can reasonably be expected but should not alter substantially the average flow into the MDC. Various other potential uses exist, such as mining, but do not appear to be immediate.

The procedures for acquisition of flow rights for hydropower use essentially include the following: 1) submission of flow utilization right application to DNRC; 2) issuance by DNRC of a public notice and subsequent public hearings if the application is contested; 3) issuance of a provisional permit if the applicant is successful in sustaining the application (this permit is sufficient to carry out construction); and 4) if the completed project uses water as originally intended, then DNRC issues a certificate of water right to complete the process.

Presently, no water rights apparently have been claimed on the MDC. Although Lewistown owns the structure, it has not filed for water rights. The proposed hydropower development will probably be viewed by DNRC as being a non-consumptive, beneficial use of water. Other than insuring adequate fish passage in both the natural and artificial channels, no other obstacles are apparent to prevent permit issuance.

1.0 PROJECT DESCRIPTION

1.1 MILL DIVERSION CHANNEL DESCRIPTION

The flow of Big Spring Creek is divided between the Mill Diversion Channel (MDC) and Big Spring Creek just prior to entering the southeastern portions of Lewistown. Water in Big Spring Creek passes through residential and business district areas, and the channel is covered through the heart of the city. The MDC is located adjacent to the spur line of the defunct Chicago, Milwaukee, St. Paul, and Pacific Railroad, and passes through industrial, commercial, and residential areas on the east side of Lewistown. The flow of the two channels is recombined at the north edge of town. Once past Lewistown, Big Spring Creek flows northward to its confluence with the Judith River, and in turn with the Missouri River (Fergus County, et al., 1969).

In response to prominent flooding (the latest being in June, 1964), the City acquired a legal assignment of rights to the use of the original MDC, along with the obligation of maintenance (Fergus County, et al., 1969, p. 12). The USDA Soil Conservation Service (SCS) was brought into the planning process in the late 1960s for an upgraded MDC. The plan objectives were 1) the alleviation of intown flooding, due largely to Big Spring Creek channel blockage by debris--especially during high flows; 2) the prevention of bank erosion/sedimentation in the earthen channel of the original MDC; and 3) the provision of increased flood control capacity and recreational opportunities in the major drainages above Lewistown.

Flood-routing analysis indicated a total channel capacity of 2,300 cubic feet-per-second (cfs) to prevent damage(s) associated with the 100-year flood event. This capacity assumed the concomitant operation of five flood control or multipurpose structures upstream of the upgraded MDC. As the Big Spring Creek channel can carry 400 cfs, the new MDC needed a minimum capacity of 1900 cfs. Consequently, the present MDC was designed and constructed by the SCS in the mid-1970s to contain such discharge levels.

The as-built channel is approximately 3,375 feet in length. It is constructed of rectangular reinforced concrete sections 20 feet wide and 8.3 feet deep, and is emplaced in stabilized earth materials. A diversion structure placed at the beginning of the channel has a radial gate of dimensions approximately 20 feet (width) by 3 feet (height), and is regulated by automatic controls. This gate will allow up to 2000 cfs to flow down the channel, with the excess flowing down the creek. The concrete-lined channel discharges into the existing (non-lined) channel just north of the bridge on Main Street. Here, a rectangular chute spillway about 150 feet in length has been constructed; the structure includes a modified SAF spilling basin at the junction of the chute spillway and the existing earth channel. Safety fences have been provided by the City as a land rights item (Fergus County, et al., 1969, pp. 38-39).

Discharge data, gathered intermittently at the Ash Street Bridge recording station, was acquired from SCS Snow Survey personnel stationed in Bozeman. The weekly mean and (±) standard deviation cfs values for the period of August, 1977 through June, 1982 are presented in Table 1-1. Preliminary hydrologic analysis of the available discharge information indicates the following: 1) a

TABLE 1-1.--WEEKLY-AVERAGE DISCHARGE VALUES
MEASURED AT THE ASH STREET BRIDGE[a,b]

Month/ Week No.	Mean cfs ± Sample Standard Deviation (No. Readings)	Month/ Week No.	Mean cfs ± Sample Standard Deviation (No. Readings)
Jan/1	Not Available (N/A)	Jul/1	178 ± 39 (13)
Jan/2	N/A	Jul/2	180 ± 22 (12)
Jan/3	N/A	Jul/3	178 ± 22 (12)
Jan/4	N/A	Jul/4	180 ± 28 (13)
Jan/5	200 (1)	Jul/5	170 ± 27 (17)
Feb/1	221 (1)	Aug/1	166 ± 28 (22)
Feb/2	Not Available (N/A)	Aug/2	169 ± 15 (22)
Feb/3	N/A	Aug/3	168 ± 12 (24)
Feb/4	N/A	Aug/4	167 ± 12 (27)
Mar/1	210 ± 16 (2)	Sep/1	163 ± 25 (23)
Mar/2	Not Available (N/A)	Sep/2	163 ± 10 (21)
Mar/3	N/A	Sep/3	164 ± 10 (24)
Mar/4	334 ± 92 (3)	Sep/4	171 ± 22 (26)
Apr/1	201 ± 29 (12)	Oct/1	167 ± 27 (20)
Apr/2	266 ± 97 (13)	Oct/2	182 ± 9 (12)
Apr/3	343 ± 212 (13)	Oct/3	175 ± 13 (18)
Apr/4	372 ± 172 (15)	Oct/4	178 ± 23 (24)
Apr/5	322 ± 168 (13)	Oct/5	179 ± 34 (29)
May/1	304 ± 181 (20)	Nov/1	170 ± 5 (25)
May/2	336 ± 147 (21)	Nov/2	172 ± 4 (21)
May/3	455 ± 293 (25)	Nov/3	171 ± 4 (24)
May/4	348 ± 188 (34)	Nov/4	185 ± 40 (22)
Jun/1	340 ± 176 (28)	Dec/1	176 ± 9 (14)
Jun/2	338 ± 203 (28)	Dec/2	172 ± 8 (9)
Jun/3	266 ± 80 (32)	Dec/3	166 ± 0.5 (8)
Jun/4	216 ± 40 (27)	Dec/4	174 ± 19 (11)

[a] Station is located in the NE 1/4 SE 1/4 NE 1/4 of Section 22 T15NR18E.

[b] Record sheets acquired from Mr. Phil Farnes, et al., Snow Survey Bureau of the USDA Soil Conservation Service, Bozeman, Montana, August, 1982.

satisfactory correlation exists between the Ash Street Bridge data and combined discharges from Big Spring(s), East Fork Big Spring Creek, below the East Fork Reservoir, and Big Casino Creek; and 2) the amount of data available on the cumulative discharge is sufficient to plot a credible weekly-averaged, annual hydrograph for the Ash Street Bridge gaging station.

The information presented in Table 1-1 represents the discharge of Big Spring Creek prior to being proportioned between the Mill Diversion Channel and Big Spring Creek (as it flows through Lewistown). In general, approximately three-fourths of the discharge is diverted through the Mill Channel, while the remainder passes through Big Spring Creek (Mr. Dan Voast, personal communications, 1982).

1.2 HYDROLOGIC ANALYSIS

The Ash Street Bridge discharge data (Table 1-2) exhibit an annual average of 222.2 $\pm$ 76.6 cfs (for the six years of record). However, when the data are graphed, as in Figure 1-1, they reveal the following distribution of values: $<$ 160.1 cfs, approximately 20 percent of the time; 160.1 to 200.0 cfs, approximately 53 percent of the time; and $>$ 200.0 cfs, approximately 27 percent of the time.

The present (and approximate) 3:1 proportioning of the Ash Street Bridge discharge between the MDC and Big Spring Creek possibly could be changed to allow greater volume to flow down the MDC. This change would allow greater hydroelectric generation capacity than if the status quo is maintained.

TABLE 1-2.--DISCHARGE FREQUENCY DATA FOR THE ASH STREET BRIDGE RECORDING STATION[a]

Discharge Interval (cfs)	Years of Record[b] 1977	1978	1979	1980	1981	1982	Σ	Cummulative Total (N_i)	(N_i/M) x 100
63.1 - 79.0	0	0	0	4	0	0	4	804	(804/804) x 100 = 100.000
79.1 - 100.0	0	0	0	0	1	0	1	800	99.502
100.1 - 130.0	0	2	0	0	0	0	2	799	99.378
130.1 - 160.0	0	0	0	115	30	0	145	797	99.129
160.1 - 200.0	1	5	167	131	125	1	430	652	81.095
200.1 - 250.0	1	3	44	11	7	4	70	222	27.612
250.1 - 320.0	2	2	14	0	17	7	42	152	18.905
320.1 - 400.0	0	6	21	0	11	5	43	110	13.682
400.1 - 500.0	0	0	20	0	5	4	29	67	8.334
500.1 - 630.0	0	0	9	0	3	3	15	38	4.726
630.1 - 784.0	0	0	3	0	4	5	12	23	2.861
784.1 - 975.0	0	0	1	0	7	2	10	11	1.368
975.1 - 1214.0	0	0	0	0	0	1	1	1	(1/804) x 100 = 0.124
							Σ 804 (M)		

[a] Raw data acquired from the USDA, SCS, Snow Survey Bureau (Bozeman, Montana).

[b] Numbers in the yearly columns represent daily readings.

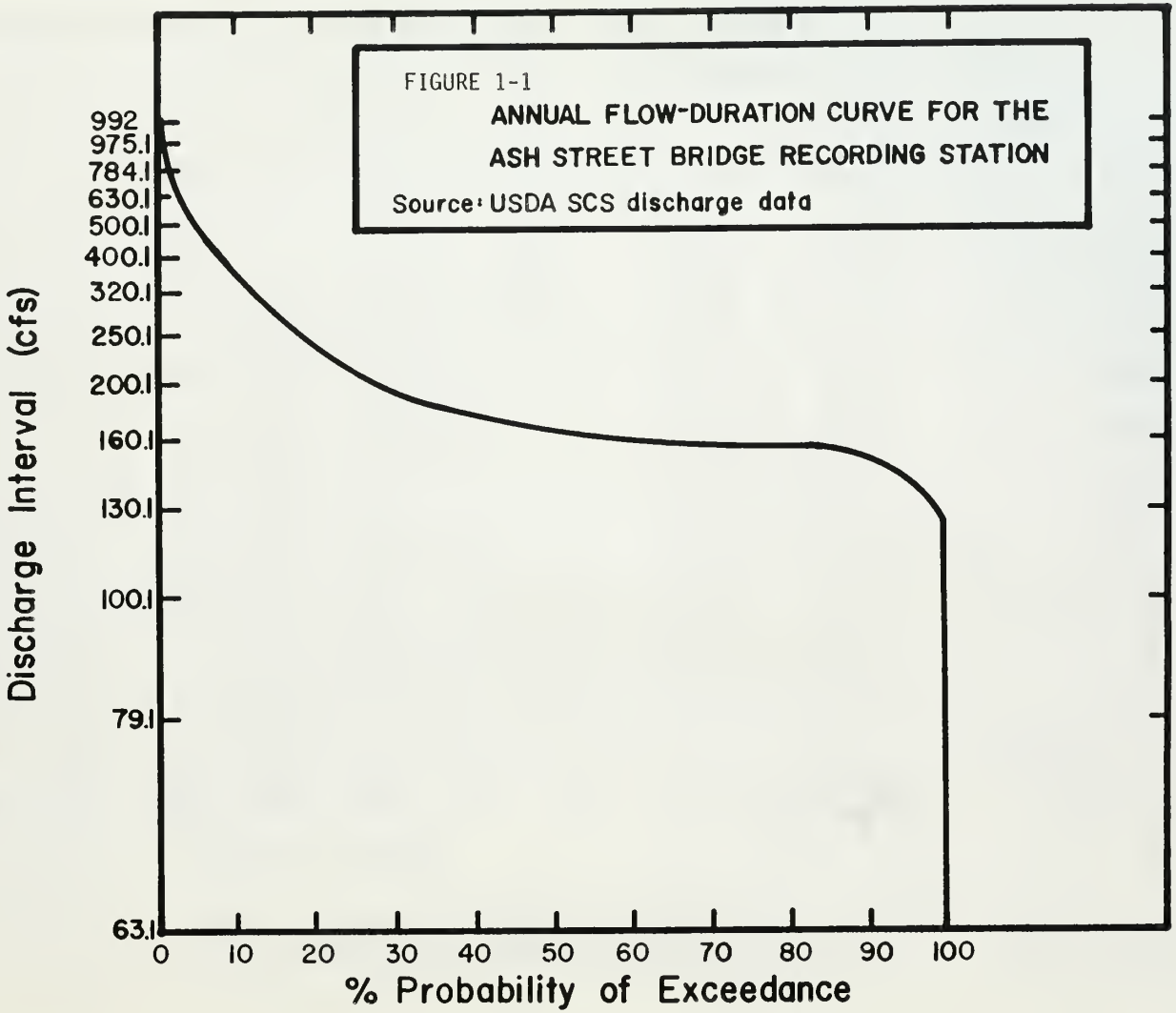


FIGURE 1-1
ANNUAL FLOW-DURATION CURVE FOR THE
ASH STREET BRIDGE RECORDING STATION
Source: USDA SCS discharge data
Discharge Interval (cfs)
992
975.1
784.1
630.1
500.1
400.1
320.1
250.1
200.1
160.1
130.1
100.1
79.1
63.1
0
10
20
30
40
50
60
70
80
90
100
% Probability of Exceedance

Clearly, all water rights must be recognized, including instream flow reserves found acceptable by the State of Montana.

However, even if all the Ash Street discharge were diverted into the MDC, a certain fraction of the discharge must remain outside of the penstock to maintain the "instream resource values". Thus, the ideal case represented in Figure 1-1 disappears, and the estimation of instream flow requirements becomes a tantamount concern. Furthermore, the present discharge schedules for the upstream flood control/multi-purpose structures could be modified. In particular, "flow-leveling" by increasing late-fall releases, and subsequently decreasing the current spring peak, would increase the reliability of operation at a given generation capacity.

1.3 POWER PRODUCTION CAPABILITIES

1.3.1 Flow Duration Curve

A flow duration curve is a graph of the flow rates for a given stream versus the percent exceedance, or the percent of time the flow exceeds a particular value. The flow duration curve for the Ash Street Bridge recording station was used in preparing this report (Figure 1-1). Since that station is located upstream of the diversion structure, the amount of water that bypasses the Mill Diversion Channel in Big Spring Creek must be subtracted from the curve. This natural channel bypass takes ~ 35 cfs in order to maintain aquatic habitat and fish passage.

Only the flow available for power production is of interest here. Any water that must bypass the turbine down a fish ladder also has to be subtracted from the flow duration curve. The selected option requires 25 cfs to flow around the power plant for 7-1/2 months of the year.

Three curves are presented in Figure 1-2. The uppermost curve represents the total flow available at the Ash Street Bridge. The middle curve is the total flow minus 35 cfs allocated to the natural channel of Big Spring Creek. The bottom flow duration curve also subtracts 25 cfs for the fish ladder for the appropriate months. The bottom two curves are used in several of the calculations presented in this section to show the revenue difference resulting from decreased flow available.

1.3.2 Gross Head and Net Head

Presently, the MDC has a drop structure of about 12 feet situated just above the proposed hydropower site. Water flows in the MDC at a depth of about 2 feet, and the channel walls are 10 feet high. To improve the gross head available, the proposed design calls for a gate being placed across the channel right at the drop structure (see Figure 1-3). It would be 8 feet high, and the channel is 30 feet across at this point. The gate would dam up the channel, with water depth varying from 8 feet right behind the gate to 2 feet just below the upstream drop structure.

The total gross head is now 16.67 feet. Head losses will occur through the trash rack, the turbine intake and penstock, and the draft tube. A slightly lower net head value will result from these structures. Since head loss is a

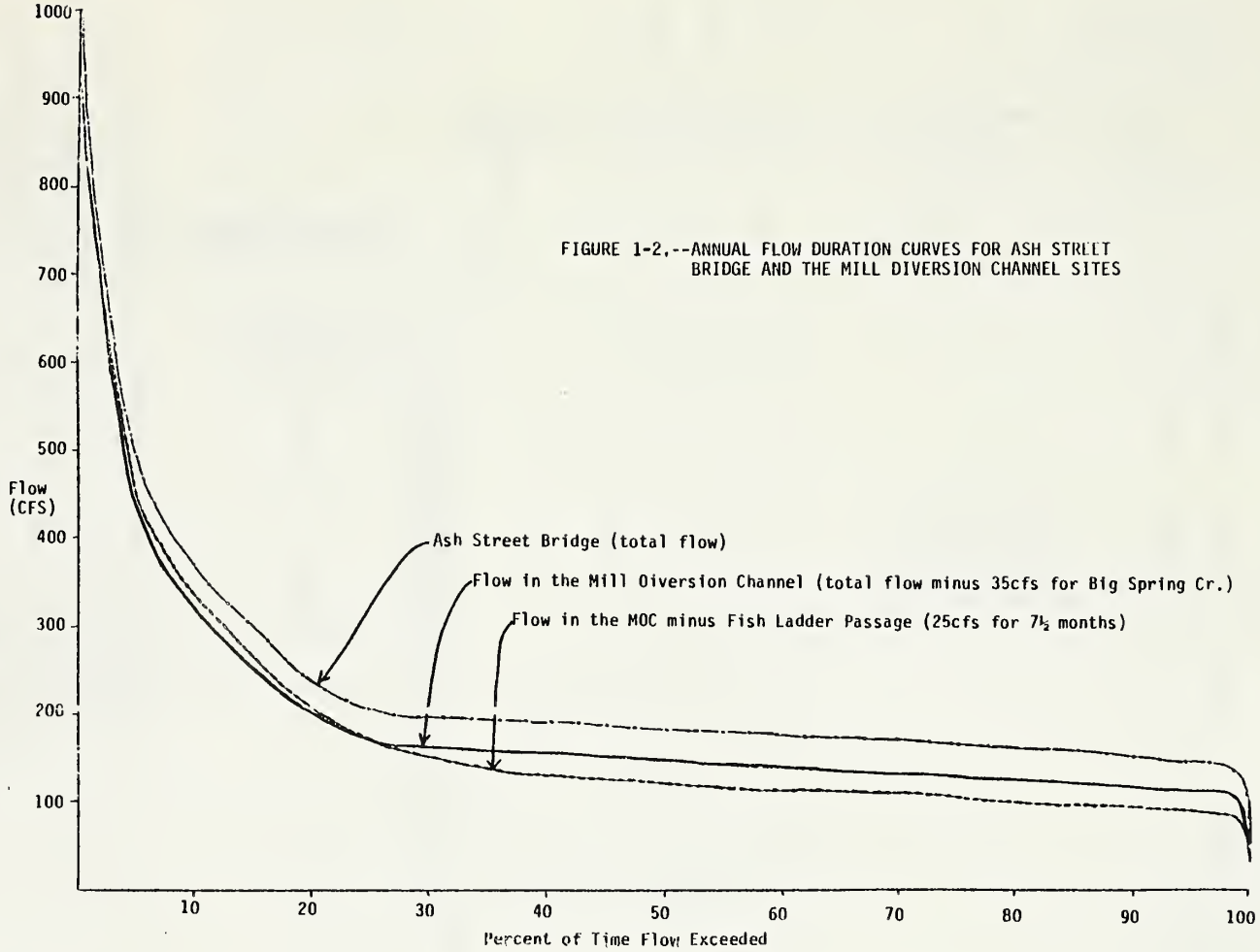


FIGURE 1-2.--ANNUAL FLOW DURATION CURVES FOR ASH STREET BRIDGE AND THE MILL DIVERSION CHANNEL SITES

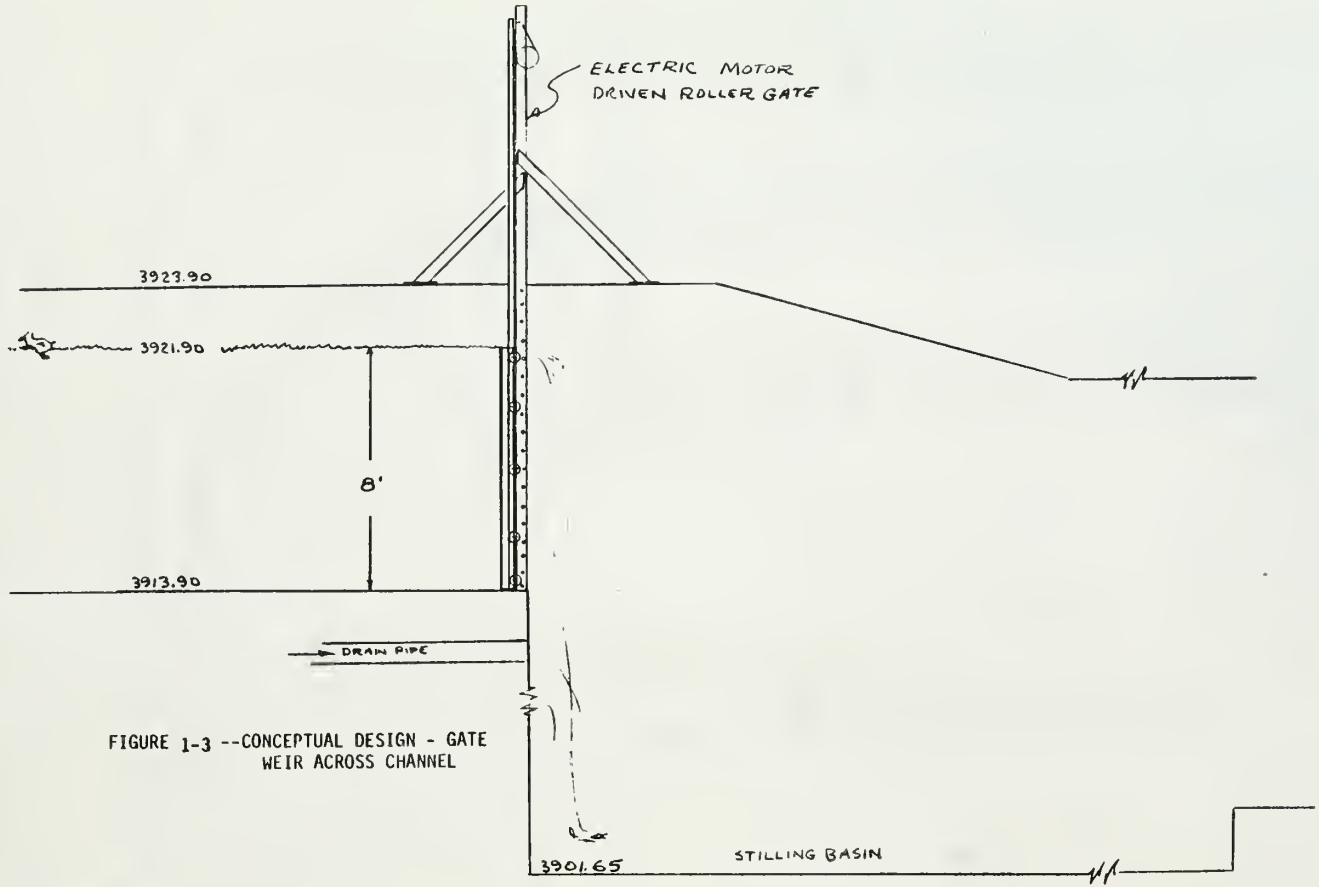


FIGURE 1-3 --CONCEPTUAL DESIGN - GATE WEIR ACROSS CHANNEL

function of the flow velocity, which varies, the head loss will also vary. However, an average value for these losses is used here to facilitate the energy calculations.

• Trash rack	0.50 feet
• Intake	0.18 feet
• Penstock	0.10 feet
• Draft tube exit	0.50 feet
• Miscellaneous	0.39 feet
• Total Losses	1.67 feet

Thus, the net head available is 15 feet. Due to water-level control from the turbine, the water will never drop below the gate height. On high-flow days, the water will flow over the gate and the gate may be lowered slightly. The net head will remain in the 15-foot range with these controls.

1.3.3 Annual Energy

The main use of a flow duration curve is to compute the annual energy available. This is done by integrating the area under the curve that corresponds with a certain turbine's capabilities. For this report, a simple numerical technique was used to find the areas.

Each turbine design will have a maximum and minimum flow it can take without being damaged. Within this range, its efficiency will vary. Many turbines are most efficient in the 80% to 100% of full flow range. To obtain the most energy from a particular installation, the efficiency curve and the flow duration curve must be "matched." One way of expressing this is to say that the design point (100% flow) is at a certain "percent exceedance." The U.S. Corps of Engineers (1979) report recommends 15% exceedance as the preliminary

design point. This means that on the high-flow days, only the turbine's maximum rated amount is allowed into the penstock, with the excess water passing over the flood gate. A condition of less than the minimum flow will probably not be encountered here. This is due to an almost constant year-round water source from Big Spring (MultiTech, 1983).

The annual energy calculation is similar to finding the capacity. However, the flow rate used is for an interval of time, and several of these intervals must be added together to find the annual value. The turbine efficiency data used are taken from the manufacturer's specifications. Using the specifications for the selected turbine (discussed in Section 1.5.1), the annual energy would be 1,243,616 kWh. This was based on the area shown in Figure 1-4.

1.3.4 Capacity

Calculating the capacity of a hydroelectric installation requires knowledge of the net head and the design flow rate. Since the flows vary over a year's time, the power plant will not always produce at the rated capacity. Only the "rated" capacity which corresponds to the design flow rate (or 100%-rated flow) is of concern here. Thus, the rated capacity is a maximum value.

An efficiency of 88% is assumed for the turbine. All other losses, including those from the generator, speed increasers, and transformer can be estimated at 7% (U.S. Corps of Engineers, 1979).

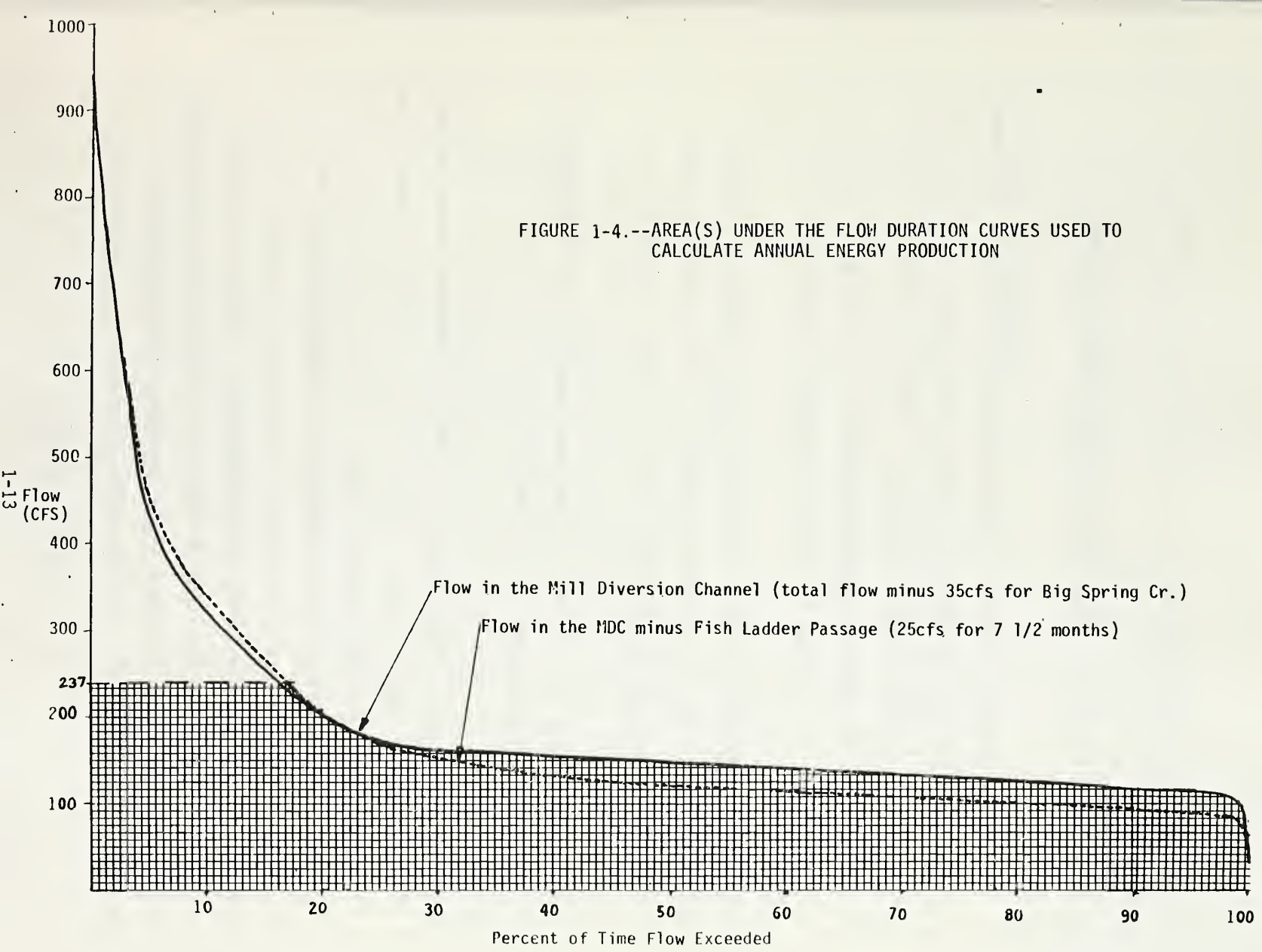


FIGURE 1-4.--AREA(S) UNDER THE FLOW DURATION CURVES USED TO CALCULATE ANNUAL ENERGY PRODUCTION

The formula for capacity is:

$$\text{Capacity (KW)} = \frac{\text{Head (ft)} \times \text{Flow Rate (cfs)} \times \text{Efficiency}}{11.81}$$

Assuming a design flow rate at 15% exceedance (254 cfs with a fish ladder; 264 cfs without), a net head of 15 feet, and an overall efficiency of .82 (i.e., .93 x .88), the capacity of this installation would be as follows:

With a fish ladder, capacity = 265 kW

Without a fish ladder, capacity = 275 kW

1.4 DESIGN CONSIDERATIONS

1.4.1 Turbine Generator Systems

Several turbine and generator systems were compared in Milestone Report 4. The recommended option is the Hydrolec ET13.

The ET13 utilizes a Kaplan runner, an induction generator, speed increaser, brake, guide vane, air valve, and draft tube. Installation also includes automatically adjustable turbine blades. This feature would lower significantly the operational costs of the facility. Budget price for the ET13 is roughly $150,000,including an electrical control panel available for $12,400. The maximum design flow for this turbine is 237 cfs with a net head of 15 feet. The overall efficiency at 100% flow is 78%, giving a maximum capacity of 235 kW. Peak efficiency occurs at 3/4 of maximum output, and is 80%.

This system would take flows down to 65 cfs, which is below the minimum for this site. Thus, the turbine will always be operating, given MDC flow conditions. Shop drawings are stored in project files at MultiTech.

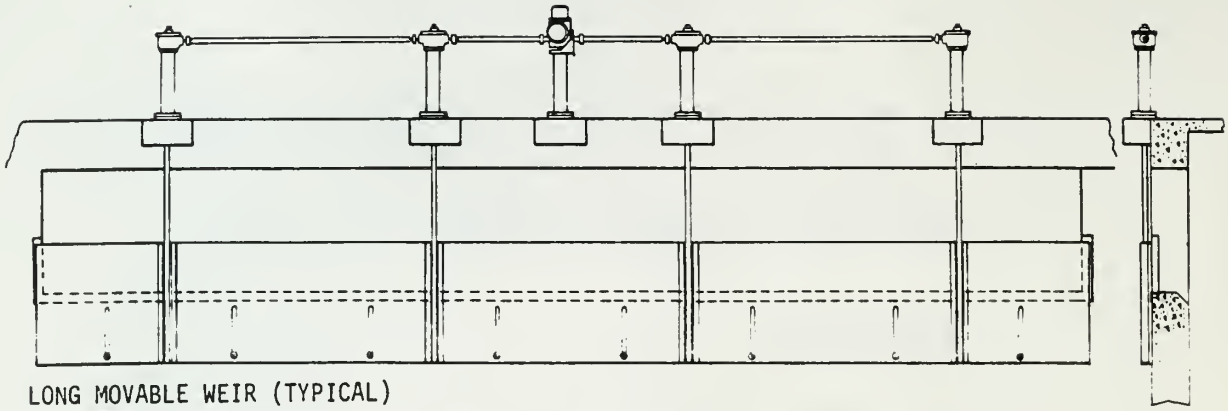
1.4.2 Gate Selection

Figure 1-5 shows the location of the proposed 30 feet wide by 8 feet high gate installation. Design requirements developed through several meetings with the USDA/SCS insist that a gate installed in the MDC be fail-safe, and that it be lowered to open.

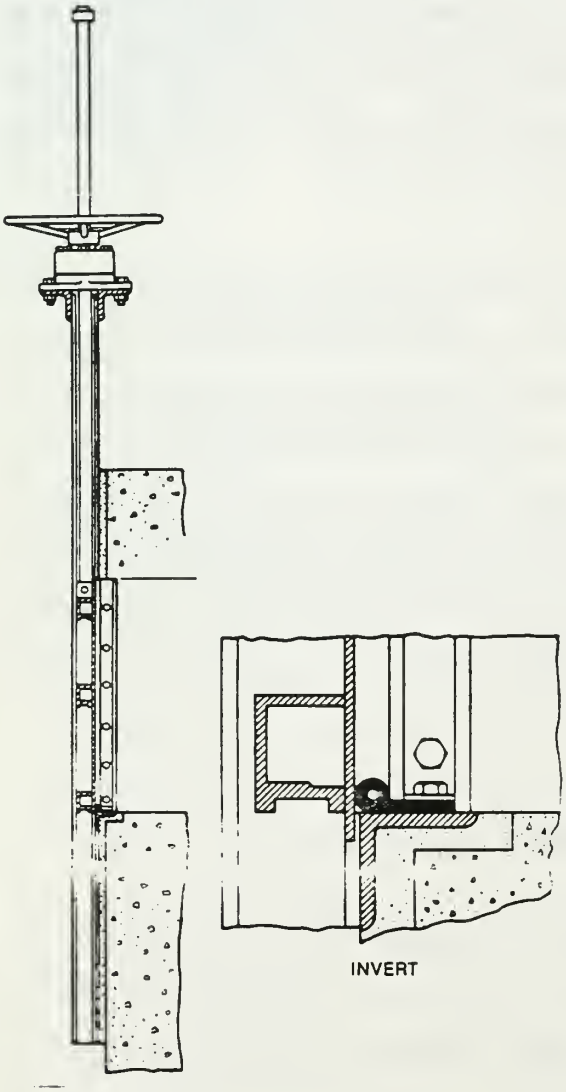
The gate recommended lowers straight down to open. It is often called a weir gate (see Figure 1-5). The Rodney Hunt Company manufacturers such a gate, and has quoted a price of from $55,000 to $75,000 for this project. As in the other types of gates, water could flow over the top of the gate. Operation would be from hydraulic cylinders located at each end. For the fail-safe requirement, accumulators would store enough pressure to drive the gate down during a power outage. This gate would be made from steel, and no piers are needed in the middle of the channel. This is by far the most economical choice.

1.4.3 Soils' Engineering Considerations

Presumably, project implementation will include the following types of activities: 1) the excavation of soil and underlying rock materials, possibly in the vicinities of the present control headgates or proposed tailrace area and certainly at the installation location for the turbogenerator unit; 2)



LONG MOVABLE WEIR (TYPICAL)



FABRICATED WEIR GATE (TYPICAL)

FIGURE 1-5.--TYPICAL WEIR GATES MANUFACTURED BY THE RODNEY HUNT COMPANY

the pouring of reinforced-concrete in the above areas; 3) the construction of small surface structures (e.g., powerhouse, transformers) requiring concrete pads for structural support; and 4) the operation of heavy equipment (e.g., sideboom tractors, truck-mounted welding units) adjacent to the existing diversion channel during the penstock installation process. Construction of permanent access roads to the project site is not anticipated. The USDA SCS soils interpretation record sheets for the area's soil series were inspected for information pertinent to the above activities, and the potential soils-related concerns are shown in Table 1-3. The information portrayed in this table represents probable a conservative (if not worst-case) assessment of soil suitability and limiting factors imposed on various engineering uses of a given soil series. In planning the Mill Diversion hydropower project, the use of the tabulated information should be given the considerations discussed below.

Sand and gravel are necessary materials in the production of concrete aggregate and as fill material. As these materials are bulky and heavy, and are subsequently expensive to transport, a source of these materials on-site would be advantageous. However, only a "fair" probability exists that sand or gravel deposits of three or more feet thickness are present within the intensive study area; and furthermore, such deposits occur largely at depths greater than 10 to 15 feet below grade.

Shallow excavations involve the removal or trenching of surficial materials to a depth of five or six feet. The constraints noted in Table 1-3 and discussed briefly below make those series present within the project area less than ideal to perform shallow excavations in. The major concerns include 1) the

TABLE 1-3.--SOIL SUITABILITY AND POTENTIAL LIMITATIONS FOR THOSE SERIES PRESENT WITHIN THE PRIMARY STUDY AREA[a]

	SUITABILITY AS A SOURCE OF:[b]				FEATURES AFFECTING:[b]	
Soil Series/Slope	Topsoil	Sand	Gravel	Shallow Excavations	Dike, Levee Construction	Building Sites (Without Basements)
Eltsac/2-8%	Poor - too clayey	Improbable-excess fines	Improbable-excess fines	Moderate - too clayey	Severe - thin layer, hard to pack	Severe - shrink/swell properties
Farnuf/8-15%	Fair - clayey and small stones	Improbable-excess fines	Improbable-excess fines	Moderate - slope	Severe - piping tendencies	Moderate - shrink/swell and slope
Lawther/2-8%	Fair - clayey	Improbable-excess fines	Improbable-excess fines	Moderate - too clayey	Moderate - hard to pack	Severe - shrink/swell properties
Nesda/0-2%	Poor - small stones	Improbable-small stones	Probable	Severe - cutbanks cave	Severe - seepage	Severe - flooding
Sudworth/0-2%	Poor - small stones	Probable	Probable	Severe - cutbanks cave	Severe - seepage	Severe - flooding

[a] USDA Soil Conservation Service "Soil Interpretations Record" (Form 5) sheets are on file at MultiTech, but available through the State Office in Bozeman, Montana. See also W. G. Holtz, 1969.

[b] The rating terminologies are defined as follows (USDA, Soil Conservation Service, 1971):

1) "Moderate" means that some soil properties are unfavorable but can be overcome or be modified by special planning and design; "Severe" means soil properties are so unfavorable and so difficult to correct or overcome as to require major soil reclamation and special designs.

2) Regarding soil suitability, "Fair" and "Poor" terms approximately parallel those definitions given to "Moderate" and "Severe", respectively. The use of the term "Probable" for Nesda and Sudworth series as a source of gravel is due to the Unified Texture classification range of GP-GM at depth in the respective soil profiles.

reduction of workability and sidewall stability in soils having clay to silty clay and gravelly texture types; 2) slopes in the range of 8 to 15 percent hindering movement of excavating equipment somewhat; 3) rare or occasional flooding and seasonal high water tables ranging from 30- to 6-inches from the surface; and 4) shallow depths (< 40") to bedrock, even if only semi-consolidated shale (as is the case for the Eltsac series).

Embankments, dikes, and levees are defined as earthfill structures constructed to hold back water. The pertinence of this evaluation to the Mill Diversion hydropower project is based on the presumed use of soil materials as a source of backfill (once the concrete structures are in place). The potential difficulties of using project area soils as fill material (Table 1-3) include the following: 1) the lack of ease in controlling moisture content throughout the Eltsac soil profile requires greater compactive forces and construction control than is commonly preferred; 2) apparently the clay content and pore space (or volume) in the subsoil and substratum of the Farnuf series are sufficient to make it highly susceptible to piping, even when the soil has been compacted previously. This second property is most prevalent in fine silty and non-plasltic silty soils having plasticity indices of five or less; and 3) the combination of fine to very fine pore structure within the "A" horizon(s), acting in combination with occasional flooding or seasonally high ground-water levels, can result in seepage problems. Surface ponding could occur within the Sudworth-Nesda mapping unit. The piping and seepage constraints may be cost effectively mitigated by installing drainage systems within the fill materials.

The primary features affecting the soils' influence on building design and construction include its ability to support structural loading with minimal settlement and ease of excavation. Additional factors include slope, susceptability to flooding, seasonal wetness, and other hydrologic conditions. The Eltsac-Lawther mapping unit exhibits adverse shrink/swell properties, as plasticity index values far exceed the "moderate" limitation of approximately 15 (USDA, SCS, 1971). The Farnuf series' lesser shrink/swell limitations do not overshadow its slope constraints, even in areas not susceptible to side hill sliding or slumping. The Sudworth-Nedsa unit is rated severe given its propensity to rare, occasional, or frequent flooding (USDA, SCS, 1971). The above constraints can be mitigated through such actions as the following: 1) the use of coarse gravel as fill material around the foundations of the powerhouse and transformer pad, and 2) the Mill Ditch's design capacity to withstand the estimated 100-year flood should minimize the influence of the "flooding criterion" on building construction/location.

1.5 ENHANCEMENT OF BIG SPRING CREEK FISHERY RESOURCES

That portion of Big Spring Creek situated upstream of Lewistown presents priority aquatic habitat capable of supporting highly valued salmonid species (U.S. Fish and Wildlife Service, 1980). Presently, the population of brown trout is below carrying capacity, due in part to the barrier to upstream migration caused by the existing Mill Diversion Channel (MDC) and headgate works at the point of diversion (Wipperman, personal communication). Unfortunately, the lack of sufficient fisheries data prevented these impacts from being recognized and then mitigated at time of MDC construction (Wipperman, personal communication).

The implementation of hydroelectric power generation at the lower drop structure (Figure 1-6) will require structural modifications to the existing MDC facility. Thus, an opportunity arises to mitigate the fisheries migration problem while incurring minimal adverse environmental impact.

Numerous approaches were considered to improve the existing fishery resource values within the upper Big Spring Creek (BSC) drainage. The selected system allows unobstructed (upstream and downstream) passage via the MDC and Big Spring Creek (BSC) through Lewistown.

Implementation of the passage option requires the following changes be made to the existing MDC-BSC hydraulic system. For clarity, the changes envisioned are presented by subsystem.

1.5.1 Mill Diversion Channel (MDC)

Either a stairstepped pool-and-weir or a Alaska steeppass system, situated on the downstream side of the MDC control gate, will allow (upstream) migrating fish to pass the obstruction and then into the Big Spring Creek (Figure 1-7).

Each pool is planned to have dimensions of 3 ft. wide x 4 ft. long x 1 ft. weir height (between pools). The progression of pools will culminate in a height equal to that flowing over the control gate during the usual low flow period (e.g., late September). The profile of the system will resemble a common stairway, and be attached to the inner wall of the "upstream" side of the MDC (Figure 1-7). The stairway will be made of rebar reinforced concrete,

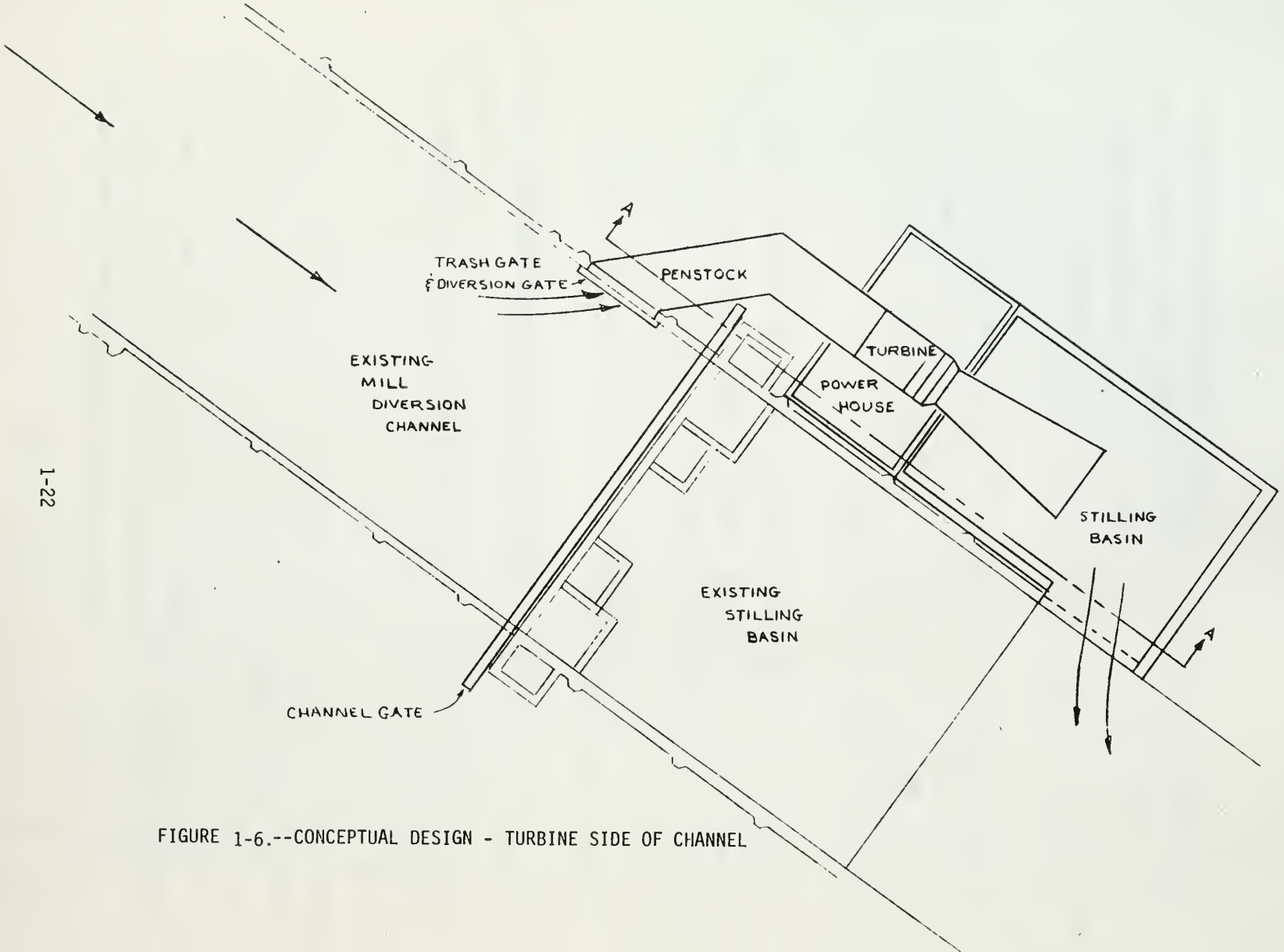


FIGURE 1-6.--CONCEPTUAL DESIGN - TURBINE SIDE OF CHANNEL

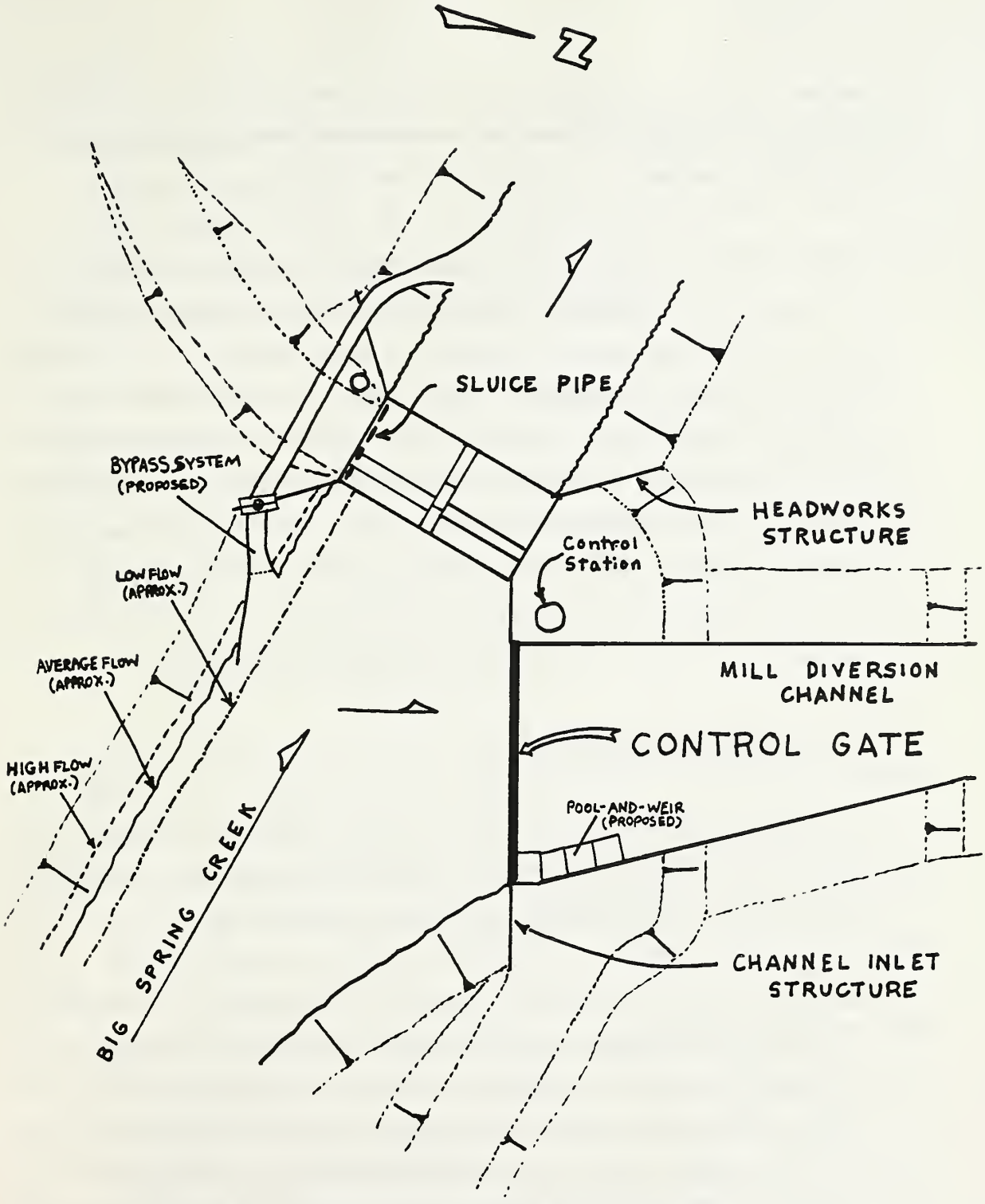


FIGURE 1-7.--PROPOSED MODIFICATIONS TO THE MDC CONTROL GATE AND TO THE BSC HEADWORKS AREAS.

and be a permanent addition to the MDC. As the pools will be inundated during the high (Spring) flows, they should not interfere with flood control functions of the MDC.

A model "A" Alaska steeppass is a transportable alternative to the concrete pool system. The steeppass is constructed of 1/4-inch alluminum alloy plate, with 1/4-inch thick fins used to dampen the vibration caused by the flowing water. The various components of each section are joined either through welding or aluminum rivets. The 8-to-10 foot sections are fastened together with aluminum bolts. The completed system weighs approximately 55 pounds per linear foot. This system has been applied with some success on Grave Creek, Kootenai National Forest, Montana (Dimeo, personal communication). As it is relatively light, it could be removed from the channel during the non-migration periods.

1.5.2 Big Spring Creek/Headgate

To avoid adversely affecting the flood control function of the gates, fish (migrating in either direction) should bypass them altogether. The bypass could be either an open channel or buried pipe (Figure 1-7).

The open channel will involve excavation and installment of a concrete-lined channel approximately 2.5 feet wide and sloping 1 to 3 percent in the downstream direction. A funnel-like entrance will diffuse the flow and attract fish into the system. The entrance elevation will be set such that at least 12 inches of water flows into the channel, even during the low flow periods. A slide or sluice gate will be installed at the upstream wing

buttress to control discharge during high flow periods or for performing maintenance (e.g., debris clearing) functions. A trash rack having 12-inch spacing (between the bars) will be installed over the entrance. Finally, a screened arch should be placed over the channel. This will prevent fish from escaping, and protect them from poaching or harassment.

An "Oregon ladder" or ordinary culvert could also be used for fish passage. The former system is essentially a baffled 24- to 36-inch pipe (Ziemer and Behlke, 1966). The latter system has also successfully passed trout species, (Dimeo, 1977; Slatick, 1971). The entrance design and position, sluice gate and transport slope will be the same as that for the open channel design.

1.5.3 Power Station/Lower Drop Structure

If the biological data given in Tables 1-4 and 1-5 are presumed to be representative of long term, future conditions, then a single-slot, vertical fishway having dimensions of 4.5 feet wide x 7 feet long x 2 feet deep per pool should handle all migration. However, any system reduced uniformly to half of these dimensions would probably be ineffective. Using a 2.5 fps flow criterion, fishway discharge requirements will range from 20 to 25 cfs.

The first segment of the fishway, extending from the MDC floor to the height of the drop structure (i.e., 8 foot rise), could be placed on either the inside (Figure 1-8) or outside (Figure 1-9) surface of the channel wall opposite that of the generating station. At that height, the fishway must bend around the vent box, then continue to rise (on the outside wall of the MDC) until it exits one or two feet below the usual surface elevation of the

TABLE 1-4.--STATISTICAL SUMMARIES OF RAINBOW TROUT AND BROWN TROUT HARVEST DATA, FOR UPPER BIG SPRING CREEK

PART A. RAINBOW TROUT

Station Code[b]	Weight (lbs.)[c]	Age Class[a] I (N; in)[d]	II (N; in)[d]	III (N; in)[d]	IV and older (N; in)[d]
B	0.40 ± 0.26(5)	1592 ± 2117(5); 8.4 ± 3.4(3)	158 ± 55(5); 11.5 ± 1.5(3)	164 ± 68(5); 13.2 ± 1.1(3)	46 ± 22(4); 15.3 ± 1.6(2)
C	0.38 ± 0.09(2)	328 ± 241(2); 5.6 - 9.2(1)	216 ± 42(2); 9.0 - 11.9(1)	76 ± 43(2); 11.2 - 13.9(1)	16 ± 6(2); 13.3 - 14.5(1)
D	0.51 ± 0.15(4)	860 ± 396(4); 7.5 ± 2.9(2)	324 ± 161(4); 11.2 ± 1.7(2)	206 ± 122(4); 13.4 ± 1.5(2)	186 ± 170(4); 15.9 ± 2.3(2)

PART B. BROWN TROUT

Station Code[b]	Weight (lbs.)[c]	Age Class[a] I (N; in)[d]	II (N; in)[d]	III (N; in)[d]	IV and older (N; in)[d]
B	1.94 ± 0.26(5)	0(5); 0(5)	8 ± 1(3); 11.5 - 14.3(1)	13 ± 7(5); 15.4 ± 1.3(3)	50 ± 25(5); 17.7 ± 2.3(3)
C	1.28 ± 0.46(2)	0(2); 0(2)	10 ± 8(2); 13.8 - 14.2(1)	27 ± 18(2); 15.0 - 16.7(1)	37 ± 4(2); 15.6 - 19.0(1)
D	0.70 ± 0.17(4)	154 ± 95(4); 7.7 ± 2.9(2)	150 ± 48(4); 11.5 ± 2.2(2)	63 ± 35(4); 14.1 ± 1.4(2)	63 ± 43(4); 18.2 ± 4.5(2)

Notes: a) Age classes defined as follows: I, 1-2 years; II, 2-3 years; III, 3-4 years, IV and older, 4-8 years.
b) Location of sampling stations as follows: B = Burleigh Ranch, T15N, R18E, S25 (~2.5 miles upstream of the diversion headworks); C = just upstream of Lewistown, T15N, R18E, S23 (~0.5 miles upstream of the headworks); D = Tresch Ranch, T15N, R18E, Sections 4, 9 (~1.5 miles downstream of the lower drop structure - power station study site).
c) Represents arithmetic mean ± sample standard deviation; number following (in parentheses) equals number of years of data.
d) Represents means and standard deviations, plus years of record, for population sizes (N) and length of fish (in inches), respectively.

Source: Poore, 1975; 1980; 1981; 1983, a, b.

TABLE 1-5.--BIOLOGICAL FACTORS RELATED TO THE DESIGN OF FISHWAY SYSTEMS.

PART A. BEHAVIORAL CONSIDERATIONS

Criterion(ia)	Comment(s)
1) General	Diel and photobehaviors (e.g., response to light-shadow patterns) are influenced by predator-prey interactions and life-stage of fish. Assume tentatively that 60% of fish movement occurs from early daylight hours to 1:00 p.m., with 35-40% moving during the 1:00 p.m. to darkness period; night passage may equal 3 to 5% of the daylight total. Young fish are often attracted to light, while adult fish are generally repelled by light; thus, consider backlighting of entrances to darkened areas. Water quality parameters (e.g., temperature/dissolved oxygen gradients, pH, salinity, etc.) also influence fish movement. Swimming depth for adult fish is usually within 2 to 6 feet of the surface.
2) "Schooling"	Most "schools" are compact during the day, and dispersed or loosened at night; daylight rule-of-thumb estimated as follows: $L = 2.4x$, where separation distance L = 2.4 times fish length (x). If fish enter the system in schools (vs. as individuals), adequate volume must be allowed in order to avoid injury to fish and to prevent "drop back" from fishway.
3) "Entry"	Fish are usually reluctant to enter the fishway, thus tend to accumulate in the first few pools encountered. Any changes in flow pattern (e.g., at turn pools) can cause fish accumulation, and possibly "jumping."
4) "Dropbacks"	Assume up to 4% of day's run will dropback (i.e., upstream migrants will return back through the ladder), despite an optimal design. A portion of this behavior can be explained by fish who have moved above their "home streams." Approximately 3 "pools" must be traversed prior to establishing successful upstream movement. Passage through a Denil or steeppass system must occur in one continuous effort in order to be successful.

PART B. SPECIES-SPECIFIC CONSIDERATIONS

Criterion(ia)	Comment(s)
1) Predominant species; size and length characteristics	See Table 1-2

TABLE 1-5.--BIOLOGICAL FACTORS RELATED TO THE DESIGN OF FISHWAY SYSTEMS. (CONTINUED)

PART B. SPECIES-SPECIFIC CONSIDERATIONS (CONTINUED)

Criterion(ia)	Comment(s)
2) Migration period and size of run on "peak day"	Presume downstream movement by brown trout (after hatching) from mid-February through late April. Presume upstream movement by rainbow from early April through May. Presume upstream movement by browns (for spawning) from early September through late-November. Presume downstream movement by rainbows from early August through late September, (Brown, 1971; Poore, personal communication). Presume maximum of 2000 upstream migrating rainbows @ 9 inches + and 0.5 lbs.+. Presume maximum of 275 downstream migrating browns @ 12.5 inches + and 1.0 lbs.+, (Table 4-2). Presume maximum accumulation of 200 rainbows below lower drop structure within a 24-hour time period, (Poore, personal communication).
3) Swimming Speeds • "burst" ("darting")	Maximum speeds of 6 feet per second (fps) for rainbow trout (of above size) and ~8 fps for brown trout (of above size). Duration limited to several seconds, and is affected by dissolved oxygen (D.O.) content and water temperature.
• "maximum sustained"	Presume values of 3.75 fps and 5.2 fps for rainbow and brown trout, respectively, Duration limited to several minutes, and is affected by efficiencies in (protein-carbohydrate) metabolism.
• "steady, critical" ("cruising")	Presume values of 2.25 fps and 3.12 fps for rainbow and brown trout, respectively. Such speeds will decrease with low D.O. content, increasing water temperatures, or increasing pollutant-toxicant concentrations. Duration can be met for hours (at a time without resting).

Sources: Bell, 1973; Brown, 1971; Clay, 1961; Hildebrand et al., 1980; Pearce (personal communication); Poore (personal communication).

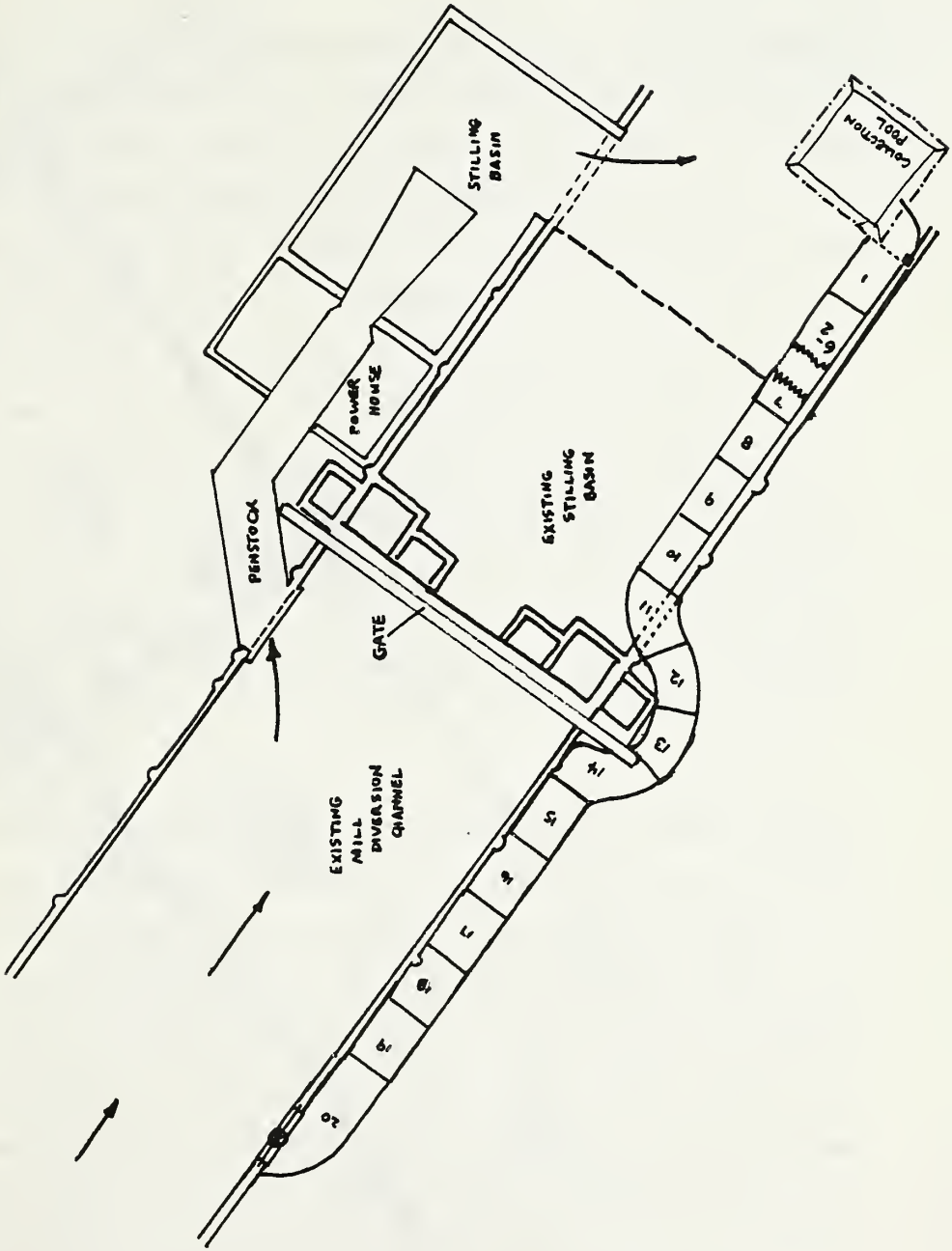


FIGURE 1-8.--VERTICAL SLOT FISHWAY, CONTAINED PARTLY WITHIN THE MDC.

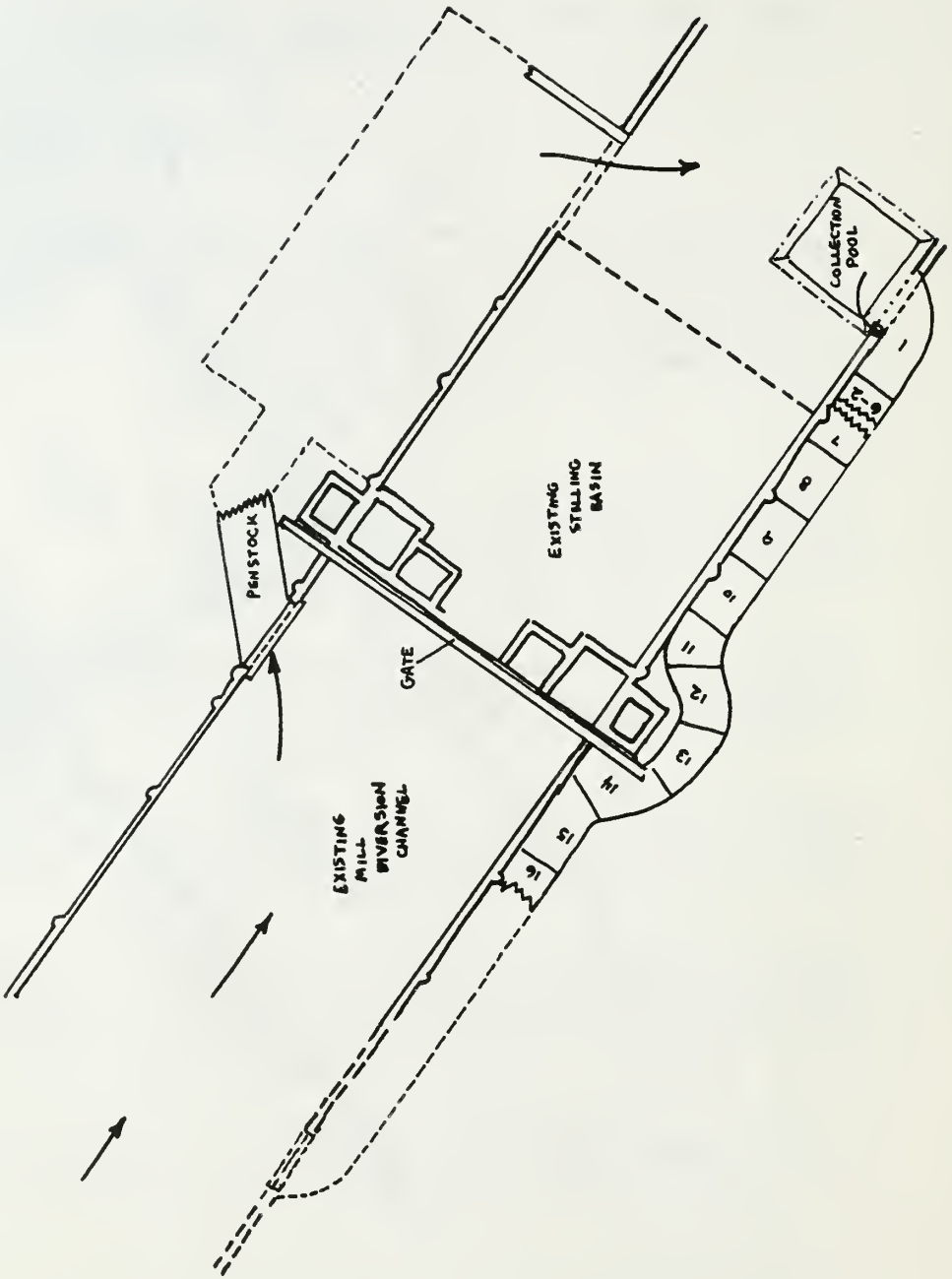


FIGURE. 1-9.--VERTICAL SLOT FISHWAY, TRAVERSING THE OUTSIDE WALL OF THE MDC.

pool. If the U.S.D.A. Soil Conservation Service allows the first segment to be anchored to the inside wall, the fishway must exit the channel so as to not obstruct the weir (or Bascule) gate when fully reclined. A collection pool, located immediately downstream of the entrance, may increase fish entry rates; such pool could be approximately 4 feet square and several feet deep. An alternate diversion scheme is the placement of 1 x 1 inch (mesh) nylon netting across the MDC at the fishway entry. The net could be attached to the channel walls via eyeblots and be suspended over the water (i.e., to prevent fish from jumping over it) via a perimeter line. Alternatively, it could be attached to floats (with attached sleeves to prevent fish jumping), and be weighed down with lead "sinkers." A slide- or sluice-type gate will be installed at the upstream entrance to control flow rates (down the fishway). The gate should be enclosed by a trash rack having 6-inch spacing between the grates or bars.

A third design alternative is the use of an Alaska steeppass system. In this case, the lower span will exit the channel obliquely and climb at a 1:4 slope to the first resting pool. The lower entrance must be situated so that it is submerged even during the low-flow period. The steeppass is placed in an excavated channel, possibly concrete-lined to avoid collapse of unstable walls. This ladder terminates at the first, concrete-lined, resting pool. This pool would be approximately 4 feet wide x 5 feet long x 2 feet deep, and have a surface (pool) elevation approximately equal to that of the sill (of the lower drop structure). The upper span will then rise at a 1:5 slope to the upper pool, which then exits into the "power pool." The bottom of the resting pool should be one to two feet below that of the "power pool" elevation. For safety, the channel enclosing the steeppass should be stabilized

(e.g., concrete lined) and fenced off. Flow rate through the steeppass and debris accumulation will be controlled in the same manner as discussed for the vertical slot fishway (above). A barrier net or drag seine should also be considered for diverting the upstream migrating fish into the lower steeppass.

1.5.4 Lower Confluence of the MDC and BSC

The present conditions will be maintained, as implementation of the above systems will allow free passage of fish in either the natural or man-made channels.

1.6 PROJECT IMPLEMENTATION

Critical points in the Project Schedule (Figure 1-10) are the following: 1) avoided cost decision by the PSC in late summer; 2) timely submittals of license and permit applications; 3) a sufficient interval for the permitting process; and 4) construction during warm weather when low stream flows and a minimum fish passage are present. These and other factors affecting the implementation of the project are discussed in the following sections.

1.6.1 Avoided Cost

Economic viability of the MDC hydro project was based on the current avoided cost that was issued by the Montana Public Service Commission (PSC) through Orders 5017 and 5017A in October 1983. New avoided cost hearings began May 7, 1985 with an expected decision in late summer of 1985. Previous PSC directives

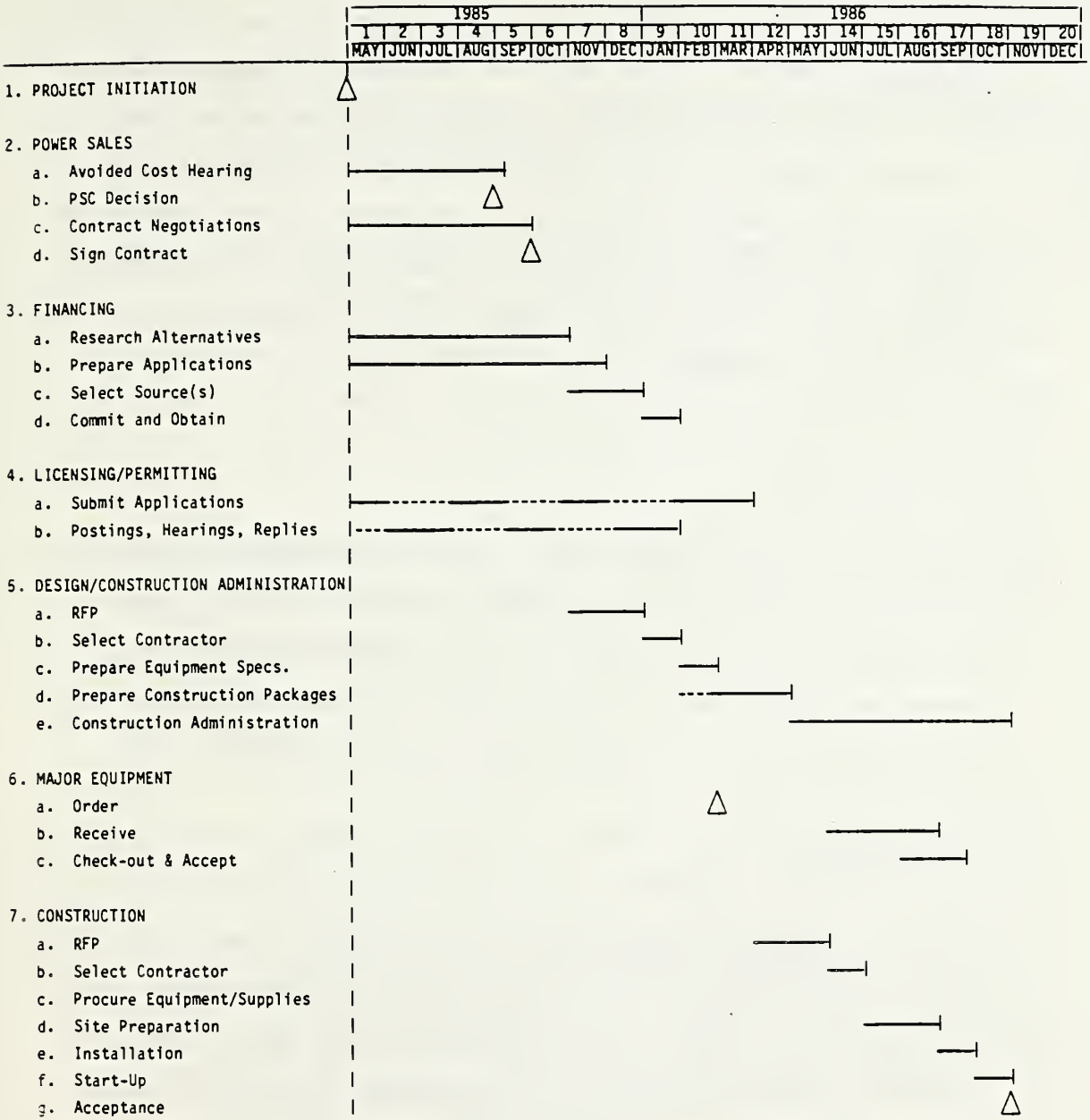


FIGURE 1-10.--PROJECT SCHEDULE

in the fall of 1984 indicate the new avoided cost will be retroactive to mid-December 1984 for all new contracts considered by Montana utilities. Reconsideration of the avoided-cost rate during a period of power surplus, particularly underscored by the rate base decisions on Colstrip No. 3, indicates a possible lowering of the rate. Consequently, the PSC hearings and findings on the avoided cost will be of intense interest and consequence in project planning. Participation and monitoring of the hearings by the City of Lewistown is recommended.

1.6.2 Power Sales

Negotiation of a power sales contract with MPC should commence immediately. The type of contract (Levelized, Partially Levelized, Escalated), the term, liability bonding, and other factors can be addressed prior to the determination of the avoided cost rate. Contractual commitment should occur only after assessing the impact of the new avoided cost on the project.

1.6.3 Financing

Milestone 6 suggested a combination of DNRC funding and a general bond issue to obtain project financing. This could produce the lowest overall interest rate; however, the timing in obtaining the DNRC money may be unacceptable. Funds under that program require legislative approval and would not be available until July 1987.

Other financing sources should be monitored and evaluated on a continuous basis. State and national politics, as well as the local and national economy, will affect the financing alternatives.

If the Federal Energy Investment Tax Credits are extended beyond their current termination of January 1986, then third-party financing may be a possibility. Although higher interest rates might be necessary to attract institutional investors, the potential value of the tax credits to private investors could still make the total project financially attractive.

Inquiries and applications for financing should be made as soon as adequate information is available. Once again, early inquiries will help define the options and requirements.

1.6.4 Licensing

The primary license to be obtained is the Federal Energy Regulatory Commission exemption from licensing. Section 2.1.3.2 of the Milestone 5 Report details the procedure and basis for licensing exemption for this size and type of project. Sufficient information currently exists through this study's milestone reports to allow preparation of the application. The effort would be worthwhile, as the possession of the exemption will assist discussions with MPC, State agencies, and financing institutions.

1.6.5 Permitting

Two preliminary permit applications should be submitted immediately. These are the FERC preliminary permit and the DNRC Water Right permit. Other permits, as shown in Milestone 5, can be requested as the project further matures, but these two should be completed early to establish the project's priority and water use claims. A complete listing and more detailed discussion of the required permits are contained in the Milestone 5 Report.

1.6.6 Postings, Hearings, and Replies

Any licensing or permitting process requires posting the applicants' intent for public scrutiny and comment. Following the applications, a period of time up to six months is anticipated for activities related to the posting and comment procedure and to answering various questions from involved government agencies. These questions will require answers before final permits can be issued or before the FERC will issue a final ruling on the exemption. At the conclusion of these activities a decision point will be reached as to whether to drop, to shelve, or to proceed with the project, and to decide which financing mechanism to use.

1.6.7 Bond Issue

Assuming that the City of Lewistown chooses the municipal bond route for financing the project, a bond issue must be prepared for election. An effort will be required to inform the voters as to what is at stake, how much it

costs, how the bond is to be repaid, and how the public will benefit from the project.

1.6.8 Design

Upon the acquisition of financing -- whether voter-approved bonds, state monies, private sources, or a combination of all -- the contracting of a firm to do the Final Design and Contract Administration may be initiated.

A Request for Proposal (RFP) will be written, released, and responses evaluated by the City. Predetermined criteria including requirements for responsiveness to the RFP, cost, schedule, familiarity with hydro projects (specifically this project), and ability to perform will be used to assess and select a contractor. After the selected firm is under contract, the design work as based on this feasibility study may begin. Primary contractor activities will be to prepare facility and equipment specifications for the bid packages.

1.6.9 Construction

When the bid packages are ready, an RFP for a construction firm can be released. Criteria similar to those used for the Design/Construction Administration contractor will be used to select the Construction contractor. Although there are many ways to handle equipment and supply purchases, the construction firm will be responsible for only the procurement of non-major equipment items and for construction supplies. The City will purchase and furnish major equipment. The primary responsibilities of the constructor will be site preparation and equipment check-out, installation, and start-up.

At the successful conclusion of start-up and subsequent tests (i.e., operation at different conditions and attainment of performance goals), the City of Lewistown will formally accept the system from the construction firm.

During the above activities, the Design/Construction Administration firm will be providing monitoring and guidance to the Construction firm for the City. Duties will include assurance that quality, safety, and environmental requirements are being met, monitoring of schedule and procurement activities, and approval of design changes. This firm will also develop acceptance test procedures and criterion, and operation and maintenance manuals.

1.6.10 Equipment

Direct procurement of major equipment items by the City of Lewistown offers several potential advantages. Savings could be realized by the City by the elimination of the administrative handling charge that is normally added by the purchaser. This can vary from 5% to 20% of item cost. A major advantage, as shown in the schedule, is the possibility of facility start-up in the Fall of 1986 versus late Summer of 1987. If equipment ordering is delayed until the Constructor is under contract, then the above schedule slippage is necessary to allow for delivery and for good construction weather. Another advantage of direct purchase is the schedule control that the City can exert on equipment deliveries. Also, first-hand communication with critical vendors increases the liklihood of receiving the "best-fit" equipment at the time desired.

2.0 ECONOMICS

2.1 CAPITAL COSTS

2.1.1 Power Plant

The total capital costs for the power plant are $150,000 for the ET13 (automatic blades). The price quoted by Hydrolec is for all the power plant equipment. The other items necessary, such as the trash rack and the structural works, are included in the following section.

2.1.2 Site Preparation

To accommodate the turbine generator system and the weir (or Bascule) gate, the items below must be included:

- Steel house and foundation, including stilling basin, $31,000;
- Inlet works, including trash rack, $15,000; and
- Preparatory structural work for the gate installation, $5,000.

Total costs estimated for site preparation are $51,000. All costs were based on the Richardson rapid estimation system (Richardson Engineering Services, Inc. 1981).

2.1.3 Gate

The 30 feet x 8 feet weir gate will cost $65,000. Any structural work needed to the channel is included in the above section.

2.1.4 Electrical Installation

2.1.4.1 Internal Wiring

The main feed from the generator to the pad mount transformer will be 480 volts, three-phase, with three 500 M.C.M. copper conductors insulated for 600-volt service. These conductors will be carried in 3-1/2 inch rigid conduit from the steel building (which contains the generator) to a point just west of the building where a pad-mounted transformer will be located on a concrete foundation.

Considerable wiring is required from the turbine-generator to the main control panel. All of this wiring installed will cost $7,100.

2.1.4.2 Connection to Montana Power Company's Distribution System

The pad-mounted "step-up" transformer will be a 225 kVA, three-phase, 4,160-to-480 volt unit with four 2-1/2% taps and bayonet fusing. From this location, adjacent to the steel building containing the turbine-generator and the control panel, an underground feeder will be required. The underground feeder will be rated 4,160 volts, four-wire.

The underground feeder will consist of three #2 aluminum individual conductors with concentric neutral wires insulated for 15,000 volts (as 5,000 volt line is no longer available). These conductors will be bundled and buried directly in the ground. They will run in a northerly direction from the pad-mount transformer along the western side of the stream, to the west end of the bridge on Main Street. These conductors will be carried in three-inch, rigid conduit along the upstream side of the bridge and then go underground again along the southerly side of Main Street, until they have crossed High Street. At this point, they will enter a junction box and then proceed along the easterly side of High Street until they intersect the alley where Montana Power Company's main distribution system is located. Here, the three conductors will be carried up the distribution pole in three-inch rigid conduit and be terminated with standard devices. This input from the generator will be protected with open type cut-outs and lightning arrestors all rated for 4,160 volt operation. The total installed cost (including the pad mount transformer) is estimated to be $12,900.

2.1.5 Fishway Installation Costs

The conceptual designs described in Section 1.5 were utilized to calculate preliminary cost estimates for the design and installation of the "passage" fishway system option. Labor and materials required for site work (e.g., bypass trench excavation) and concrete work were estimated via use of the Richardson rapid estimation system (Richardson Engineering Services, Inc., 1981). The resulting 1981-based costs then were escalated by 30.2 percent to compensate for presumed, cumulative, inflation effects from 1981 through

September 1985. An additional 10 to 20 percent contingency factor was added to certain fishway subsystems to provide for a minimal level of architectural-engineering-drafting services, but it does not include the preparation of construction bid packages, site staking, or sophisticated geotechnical field investigations. Lesser (or common) hardware items were priced from current (1983-1984) engineering supply catalogs. Barrier net costs were quoted by a representative from a reputable netting manufacturer.

The engineering concepts for this fishway system are described in Section 1.5. The installation costs for a fish passage device, located across the channel from the turbogenerator station, will probably range from $20,600 to $41,600. As shown in Table 2-1, Part A, actual costs will be determined by which of the three design options is finally chosen. Preliminary cost estimates for the remaining portions of the recommended "passage" fishway are shown in Part B of Table 2-1.

2.2 OPERATION AND MAINTENANCE COSTS

2.2.1 Power Plant and Gate

The gate selected for installation is designed for automatic operation. A weekly inspection of one hour should be sufficient to maintain optimum performance. The cost, assuming $12/hr, totals $624 annually.

Turbine alternative ET13 is designed for automatic operations. A weekly two-hour inspection should suffice to check operation and to clean the trash rack.

TABLE 2-1.--PRELIMINARY COST ESTIMATES FOR THE "PASSAGE" FISHWAY, OPTION NUMBER 1[a,b]

PART A. Fish Passage At The Hydropower Station Site

Subsystem	Design Options	Cost	Minimum	Maximum
Power Station/ Lower Drop Structure	Vertical Slot (I/O MDC)[c]	$20,600	$20,600	--
	Vertical Slot (O MDC)[c]	$41,600	--	$41,600
	Alaska Steeppass (O MDC)[c]	$34,900	--	--
		Total	$20,600	$41,600

PART B. Other Recommended Subsystems For Option Number 1

Subsystem	Design Options	Cost	Minimum	Maximum
MDC Control Gate	Pool-and-Weir	$ 1,000	$ 1,000	--
	Alaska Steeppass	$ 3,700	--	$ 3,700
BSC/Headgate	Open Channel (Bypass)	$18,300	--	$18,300
	Buried Pipe (Bypass)	$13,300	$13,300	--
MDC-BSC (lower) Confluence	None (Status Quo)	-0-	--	--
		Total	$14,300	$22,000
		Grand Total(s)	$34,900	$63,600

Notes: a) Costs were converted to the nearest one hundred dollars, from those calculated (to the nearest cent) using the Richardson system (1981).

b) Conceptual design described in subsection 4.2.2.1 of the Milestone No. 4 Report and Section 1.5 of this report.

c) I/O equals inside/outside MDC's inner wall.

An annual two-day inspection also is required. The total O & M cost for this option would be $1416 per year.

A reserve replacement fund must be established also, in which money is set aside for large equipment replacement in the future. This amount would be $5,000 in the first year.

The estimated total O & M costs are $7040/year for turbine alternative ET13. Each following year's costs will be escalated by 4% to account for inflation of labor and materials.

2.2.2 Fishway

Hildebrand et al. (1980) have estimated annual O & M costs as being from 2 to 3% of the unit (initial capital) costs. For this study, O & M costs were estimated for each of the subsystems, then summed. Thus, the first year's O & M costs for the passage option would vary from ~ $950 to $1780. The actual cost will depend upon which of the particular hydropower station-related fishway designs is chosen (see Table 2-1). These costs will be escalated at 4% also.

2.3 OTHER COSTS

2.3.1 Mitigating Costs

Mitigating costs, as related to environmental and institutional concerns discussed in Section 4.0 of the Milestone 6 Report and Section 5.0 of the

Milestone 4 Report, were incorporated into the base cost estimate. The principal mitigating costs were those involving fisheries enhancement at the power plant. Other mitigating measures are part of the Engineering Costs (Operating and Maintenance Plans, Ice Loading Analysis, and Water Level Impact Determination, etc.); and the Construction Costs (land and grass restoration, fencing, structural aesthetics, etc.).

2.3.2 License Costs

From this study, Lewistown will possess all necessary information to complete application for exemption from FERC licensing; and any additional work required for application probably can be performed by personnel already on payroll. Therefore, the estimates do not include costs for the licensing process.

2.3.3 Miscellaneous Costs

Other miscellaneous costs, such as preparation of legal materials, financing or bonding expenses, etc., are all items that can be done by personnel already on payroll and are therefore not included as separate line items on the estimate. Unexpected costs are covered under the 20% contingency category.

2.3.4 Administrative Costs

Costs for construction-related administrative activities were included as part of the base estimate under engineering and construction management. Other administrative costs were not included in the estimated total costs

since the City Government routinely administers or conducts similar size projects and could execute this project with personnel already on the payroll.

2.3.5 Operation and Maintenance Costs

The routine inspections and lubrications will be performed by Lewistown personnel already on payroll; thus, the incremental costs are expected to be relatively minimal. Maintenance beyond that normally required could be contracted to Fergus Electric, if appropriate; or to the equipment supplier or other knowledgable persons. This cost is included in the percentage (4%) used for O&M in the subsequent economic analysis.

2.3.6 Equipment Replacement Allowance

An equipment replacement allowance is included as part of the operation and maintenance estimates used in this report. Typically, this type of equipment is highly reliable (once the start-up activities are complete) and should require minimal replacements for many years. In the event some unforeseen major breakdown does occur, costs can be covered from the O&M reserve, or if necessary, from earnings.

2.3.7 Fees

Anticipated fees for permits, easements, licenses, etc., are expected to be minimal, and a separate expense category was not used.

2.3.8 Wheeling Costs

Since the energy produced will be marketed to the Montana Power Company (MPC) and the connection to the MPC distribution grid is direct, no wheeling costs were included in the estimate.

2.4 DNRC GRANT PROPOSAL

The City of Lewistown and the feasibility study contractor, Fergus Electric Cooperative, submitted a grant application in October 1984 to DNRC for the design and building of this project. The budget for the application was modified from the budget presented in Section 5.0 of the Milestone 4 report. The latter budget has been the basis for the discussion to this point.

A copy of the grant application budget is included in Table 2-2. The highest estimate for the fish passage device ($41,600) was used as the base project. Significant differences between the Milestone 4 budget and the grant application budget are caused by the increased monies for designated fisheries enhancement at the head of the MDC. These supplemental expenses are in addition to the base project and specifically include: site preparation; fish passage equipment; and engineering--a total of $65,200. These additional costs caused construction interest to increase by $5,600 and the contingency estimate to increase by $12,100.

The City of Lewistown also listed $33,800 for administrative costs, including $17,200 for City salaries, $5,000 for FEC salaries, $600 for supplies and materials, and $1,000 for communications (telephone, postage, legal advertise-

TABLE 2-2.--ECONOMIC ANALYSIS

Power Plant (ET13, automatic blades)	$150,000
Site Preparation	71,000
Gate	65,000
Internal Wiring and Electrical Interconnection	20,000
Fisheries (Option 1 - "Passage")	61,600
Subtotal	$367,600
Engineering (16%)	58,000
Subtotal	$425,600
Interest during construction (10%)	42,600
Subtotal	$468,200
Contingency (20%)	93,600
Subtotal	$561,800
Administration	33,800
Total	$595,600

The capital recovery payment on the total costs is $74,050/year (for 15 years).

Operation and maintenance costs are $7,040/year for the power plant and $1,780/year for the fish system; these costs total $8,820/year.

ment). Two-thirds of the salaries (including all of FEC's) and half of the supplies and communications (a total of $22,100) were to be proposers' contributions. A portion of the $22,100 could be supported by privately raised funds (general bonds) and a portion would be provided as in-kind services. It is assumed that all of FEC's portion would be contributed.

Consequently, for the subsequent project financial analysis the project cost value of $488,900 from Milestone 4 Report, will be taken as a lower bound, and the value of $595,600 from the grant application budget will be taken as the upper bound. The actual figure will depend on the inclusion of the costs of the additional fisheries enhancement into the costs of the hydropower plant. Separate funding of the fisheries enhancement may also be desirable. Also, the City of Lewistown will need to assess the source of funding, if any is desired, for administrative costs associated with the project.

2.5 BENEFITS

Benefits are figured entirely on the basis of the value returned to Lewistown through the sale of power generated and the capacity factor. The revenues are based on data taken from the engineering analysis and from calculations for average annual energy production and system design capacity. The rates applied are derived from rate schedules prepared by the MPC in response to the Montana Public Service Commission (PSC) Order 5017 and Order 5017A; This document is dated December 20, 1983.

There is another benefit flowing from the project, namely fisheries enhancement. The planned design for this project includes methods for fish migration upstream. Presently fish movement to upstream spawning areas are severely restricted by the MDC structure. Increased fishing opportunities could have a significant economic impact by attracting out-of-town fisherman.

Another benefit, although more indirect, is the potential tourist attraction the dam and power plant will provide. A green area, picnic facilities, the power plant, and fish jumping up the fish ladders could attract passing motorists to stop and enjoy the area.

Using only the value of the marketed electricity the total annual revenue is $88,740.

2.5.1 Value of Energy

The value of energy used for this analysis is obtained from the PSC/MPC Order 5017, Schedule QFLT-84, Table I, Page 4. The fully levelized category value was selected as giving the best return and cash flow for the Lewistown Government. A contract term of 35 years was used to establish predictability and long-term stability, and to reduce risk.

The energy rate used in this report was developed using the guidelines set forth by the Montana Power Company and approved by the Montana Public Service Commission (MPSC order No. 5017, December 20, 1983). Use of the fully levelized long-term rate of 35 years results in an energy payment of $0.059 per kWH plus a capacity payment of $91.87 per kW per year. A capacity factor

(CF) that compares predicted annual energy production to rated capacity must be included to calculate the specific capacity payment. With the fish ladder, CF equals 0.604; and without the fish ladder, CF equals 0.677.

The annual capacity payment may be calculated by the relationship shown in the Qualifying Facility Long-Term Power Purchase (Schedule QFLT-84, MPSC Order No. 5017).

$$\text{Annual Capacity Payment} = (\text{ACCR}) \times (\text{AAKW}) \times \frac{(\text{AACF})}{.85}$$

where ACCR = Annual Contract Capacity Rate

AAKW = Annual Actual Capacity Rate

AACF = Annual Actual Capacity Factor

For estimates in this study the equation becomes

$$\text{Annual Capacity Payment} = (91.87)(235)\frac{(.604)}{.85}$$

$$= \$15,341;$$

and,

$$= (91.87)(235)\frac{(.677)}{.85}$$

$$= \$17,195$$

The energy payments are

$$\text{Annual Energy Payment} = \text{ACER} \times \text{kWHe}$$

where: ACER = Annual Contract Energy Rate

KWHe = Kilowatthours of energy supplied

therefore

$$\text{Annual Energy Payment} = (.05902)(1,243,616)$$

$$= \$73,398;$$

and

$$= (.05902)(1,392,885)$$

$$= \$82,208$$

Total annual revenues, without reduction for transmission losses and plant availability, are $88,740.

2.5.2 Value of Capacity

Per Order 5017, the capacity value was calculated and is shown in Milestone 4 with the energy calculations. Order 5017 specifies the procedure to be used in determining value of capacity. The results of the calculation are also shown on page 5-9 of Milestone 4 Report, including the effects of the fish passage, was an estimated $15,341 for the capacity payment.

2.5.3 Avoided Cost Rate

Recent decisions by the Montana Public Service Commission (PSC) on the long-term electric avoided cost rates has complicated the process of estimating revenue as well as the determination of the most beneficial contract terms.

On October 16, 1984 the PSC issued Utility Division Docket No. 84.10.64, Order No. 5091. This order asked for comments on the present avoided-cost rate. The stated impetus for another consideration of avoided cost rates was "rapidly changing market conditions". An order issued in early December directed Montana Power Company (MPC) to sign all contracts from Qualified Facilities (QFs) that had fully negotiated contracts with MPC. The PSC also directed that avoided cost hearings be held as soon as practical. Initial hearings were set for May 7, 1985. It was further directed that all subsequent QF contracts not falling in the "fully negotiated" area would be subject to the findings of the present avoided cost rate. This ruling obviously discourages any additional QFs from signing contracts as it would be for an unspecified payback rate.

Several contract options remain open as far as the length of contract is concerned. The present options for contracts four years and longer are: Escalating, Levelized, and Partially Levelized. Current procedures allow the rate to be set annually for the escalation and partially levelized options. Obviously, the fully levelized option is advantageous if the avoided-cost rate is desirable, and as it provides stability and cash flow potential for obtaining financing. If the rate is less desirable, then the potential advantages of escalation make those options more attractive; however, financing would probably be more difficult to obtain as future payback rates are less certain. Each QF will have to assess the viability of their project in the light of the contract options, financing availability, and avoided cost rate that should be decided by Fall of 1985.

2.6 FINANCING

Financing for the project can come from many alternate sources and can consist of grants, loans, and combinations of grants and loans. Federal, state, and local government sources were considered, along with private sources.

2.6.1 Federal Sources

The Federal Domestic Assistance Catalogue was reviewed for possible funding sources with regard to loans, grants, and loan guarantee assistance. Potential program sources were listed and follow-up telephone contacts with administering agencies were made. The general conclusion is that, although there were several possible sources in the past, the number of programs and level

of funding has become so restricted that reliance on Federal sources is not recommended.

2.6.2 State Sources

The Montana Department of Natural Resources and Conservation (DNRC) administers three programs which may provide financing for the project.

2.6.2.1 Energy Division

The Energy Division administers the Renewable Energy and Conservation Program. The grant portion of the program is used to fund research, development, and demonstration projects, and the loan program is used for projects that have reached commercialization. The maximum amount of a loan for electrical generation only is expected to be $166,800 in FY 85; 10% of this must be provided by the financial institution that administers the loan. The Energy Division loans funds at the current Federal discount rate and the lending institution applies its own commercial rate for a term of ten years. Larger projects may be financed through this program if the lending institution puts up more than 10%. However, the increased effective interest rate caused by increased financial institution participation makes other financing arrangements, such as municipal bonds, more feasible.

2.6.2.2 Water Resources Division

The Water Resources Division administers two programs: Water Development and Renewable Resources. In practice, the division treats the program as one,

with a common funding application form. The division ranks a particular project application in the program in which it has the best chance for funding. Public entities may apply for grants, or where a project has a repayment capacity, a loan or loan-grant combination. In the past, a maximum grant amount of $100,000 was established. This amount may vary depending on future demand for funds. Projects of over $200,000, sponsored by public agencies, are financed by the purchase of revenue, general obligation bonds, or other bonds by the Water Resources Division. The interest rate on the bonds is set through negotiation determined by financial feasibility and need; however, generally this is not more than the rate on Coal Severance Tax Bonds that the Water Resources Division sells to finance these activities. Repayment periods for obligations that the division purchases may be as long as 40 years. All projects must be approved by the Montana Legislature. To this end, the division has set June 15, 1986, as the deadline for applications to be funded during the 1987 biennium.

This program is far superior to any other financing program presently available. The City of Lewistown could save between 1/2 to 1-1/2 percentage points in interest because of the higher anticipated bond rating of the State of Montana relative to Lewistown's. Thus, it is recommended that Lewistown investigate to determine whether this funding source will be available as a source of financing for the project.

2.6.3 Local Sources

Two local sources considered but not recommended are taxes and Industrial Development bonds. Two other types of bonds are worth further consideration: Revenue and General Obligation.

Revenue bonds could be issued that would pledge the future revenues of the project toward the payment of the principal and interest of the issue. Such bonds do not have a "full faith and credit pledge" of the issuer. Because of this, the interest rate on revenue bonds is higher than it is on general obligation bonds. On the other hand, if revenue bonds are used in conjunction with the Water Development and Renewable Resources Programs of the State of Montana, the required interest rate will likely be lower than General Obligation Bonds of Lewistown because of the difference in bond ratings of the two entities.

General Obligation Bonds are backed by the full faith and credit of the municipality. Thus, the municipality pledges not only the revenues of the project, but also the taxing powers of the municipality to pay the interest and principal due should the project revenues prove to be insufficient. Ordinarily, this type of bond issue would have the lowest interest rate of the three types. The issue would have to be approved by the voters prior to the sale of the bonds. Without previous bond issues by the local government, the bonds would probably be Baa by Moody's rating standards. Depending on market conditions at the time of sale, it is likely that these bonds would require a yield of 1/2 to 1-1/2 percentage points higher than bonds that the

Water Resources Division would require under the Water Development and Renewable Resource Programs.

2.6.4 Private Sources

Straight commercial loans are considered not feasible.

2.7 ANALYSIS OF INTEREST RATES

To arrive at an estimate of annual interest cost, a good indicator is the yield on long-term municipal bonds. The municipal bond yield will provide guidelines for financing avenues, and also will indicate the additional interest points that could be added for other financing alternatives. Predicting interest rates is a very uncertain task, but most published authorities agree that rates, on the average, will be two percentage points lower over the next few years, based on the assumption that inflation will be controlled.

Two other factors that could greatly influence the cost of money are the Federal Reserve Board and Congressional action on the Federal deficit. The other potential influence is tax policy, "Flat Tax", etc. While interest rates, in general, fall with inflation, the factors mentioned above could keep municipal bond rates up. Due to the lack of clear indicators to the contrary, it will be assumed for this study that municipal bond rates (Baa bonds) will yield 9% to 11% through 1987, or nominally 10.0%.

If the project could be financed by combining a municipal bond issue with a State of Montana bond issue, then the overall interest rate to completely finance the project could be lower than 10%.

2.8 BENEFITS-COST ANALYSIS

2.8.1 Present Value of Cost

As previously explained, the project capital costs, in third-quarter 1984 dollars, could range from $488,900 to $595,600. The Operation and Maintenance (O&M) costs for the first year were estimated to be $8,820, with $7,040 for the power plant and $1,780 for the fish passage system. No additional charge was included for the non-power plant fisheries enhancement, as the basic O&M cost estimate is believed sufficient to cover that relatively minor cost. An escalation factor of 4% per year was used to cover equipment replacement and O & M for the project term.

2.8.2 Project Financial Analysis

This project financial analysis is the result of several (17) cases executed for a range of discount rates (synonomous with interest rates), size of investment, terms (15 and 20 years), and revenue levels. Three criteria are used to assess the economic value of a particular set of project financial conditions. The first of these is the Present Value of Net Revenue (PVNR), which brings net revenues (revenue minus expenses) back to present value based on the discount rate compounded to each year. The PVNR has to be more than the original investment for the investment to be economically worthwhile.

The second criterion is the Benefit to Cost ratio (B/C). This ratio is the mathematical expression of the first criterion; i.e., the ratio of the PVNR to the present value of the total project costs, or investment. Obviously, the B/C is over 1.0 for a economically viable project. The third indicator is the internal rate of return (IRR) expressed in percent. For the desirable project the IRR will be more than the interest rate charged for financing. Summaries of the computer financial analysis are presented in Tables 2-3 and 2-2.

Indications from the computer financial analysis are these:

- The lower project cost of $488,900 is economically attractive at the expected interest rate of 10%, 15-year repayment, and revenue based on the current avoided cost. The project at these conditions is still practical with an investment of $561,800; but not at $595,600 (the project upper limit).

- If the term is extended to 20 years then an investment of $595,600 is viable (10% interest, same revenue as above).

- An investment of $488,900 is still worthwhile at 12% interest for a 15-year repayment. (Higher interest rates were not evaluated.)

- An investment of $595,600 is still viable at 11% interest for 20-year repayment. (Higher interest rates were not evaluated.)

TABLE 2-3.--SUMMARY OF COMPUTER FINANCIAL ANALYSIS

	Case Numbers						
Input	1	2	3	4	5	6	7
Revenue	$88,740	$88,740	$88,740	$88,740	$88,740	$53,200	$53,200
Revenue Escalation	0%	0%	0%	0%	0%	3%	3%
O&M	$8,820	$8,820	$8,820	$8,820	$8,820	$8,820	$8,820
O&M Escalation	4%	4%	4%	4%	4%	4%	4%
Investment	$488,900	$488,900	$488,900	$538,000	$561,800	$488,900	$488,900
Interest Rate	10%	8%	12%	10%	10%	10%	8%
Term	15 yrs.	15 yrs.	15 yrs.	15 yrs.	15 yrs.	15 yrs.	15 yrs.
Output							
PVNR	$587,995	$660,440	$527,462	$587,995	$587,995	$403,874	$458,546
B/C	1.203	1.351	1.079	1.093	1.047	0.826	0.938

TABLE 2-4.--SUMMARY OF COMPUTER FINANCIAL ANALYSIS

	Case Numbers							
Input	1	2	3	4	5	6	7	8
Revenue	$88,740	$88,740	$88,740	$88,740	$88,740	$88,740	$70,000	$70,000
Revenue Escalation	0%	0%	0%	0%	0%	0%	0%	0%
O&M	$8,820	$8,820	$8,820	$8,820	$8,820	$8,820	$8,820	$8,820
O&M Escalation	4%	4%	4%	4%	4%	4%	4%	4%
Investment	$595,000	$595,000	$595,000	$595,000	$595,000	$595,000	$595,000	$595,000
Interest Rate	10%	10%	10.5%	10.5%	11%	11%	10%	10%
Term	15 yrs.	20 yrs.	15 yrs.	20 yrs.	15 yrs.	20 yrs.	15 yrs.	20 yrs.
Output								
PVNR	$587,995	$652,406	$571,848	$631,268	$556,402	$611,239	$445,457	$492,862
B/C	0.988	1.096	0.961	1.061	0.935	1.027	0.749	0.828
IRR	9.79	11.43	9.79	11.43	9.79	11.43	5.23	7.31

- Revenue reduced to $53,200 and escalated at 3% compared to the base case of $88,740 with no escalation was not attractive (B/C = 0.826). This was for $488,900 investment, 10% interest, 15-year repayment. An interest rate reduction to 8% did not help sufficiently (B/C = 0.938).

- For the investment case of $595,600, 10% interest, 15-year term, a drop in revenue from $88,740 to $70,000 annually (no escalation) made the project economically unattractive (B/C = 0.749). An increase in term to 20 years was not enough help (B/C - 0.828).

The analytical results show that while both investment values are economically viable with the right set of conditions, they underscore the increased financing flexibility that exists with the lower value ($488,900).

2.9 MARKETING ARRANGEMENTS

2.9.1 Sale to the Montana Power Company

Central Montana G&T Cooperative, Inc. has contracted for power supply to Fergus Electric Cooperative and will continue to do so. All of the power has historically come from the system of Montana Power Company. In 1981 total cost of purchased power was $794,713 for 78,703,609 kWh; this translates to an average cost of about one cent per kWh.

On May 4, 1981 the Montana Public Service Commission (MPSC) adopted Rules and Regulations governing the purchase and sale between public utilities and qualifying cogeneration and small power production facilities (MPSC, 1981).

The Montana Power Company has adopted a rate schedule LTPP-82 Supp. #1 for Long-Term Power Purchase (MPC, 1982). When this rate is applied to the preliminary kW and kWh calculations for the Fergus Electric Cooperative Mill Diversion Channel project, an average rate of 6.41¢ per kWh results.

2.9.2 Use by Fergus Electric Cooperative Directly

Service to Fergus Electric Cooperative in the Lewistown area comes from delivery points on the Montana Power Company system nearby. All of the output of the Mill Diversion Channel project could easily be delivered to the distribution system of Montana Power Company, and with a small amount of wheeling, provide for this amount of power to be used by Fergus directly. In this case, the power provided would be worth approximately one cent per kWh to Fergus, less the possibility of a small wheeling charge.

This second option should not be given any consideration, because the sale of power to Montana Power Company will bring in over six cents per kWh as compared to less that one cent for direct use.

3.0 ENVIRONMENT

3.1 PRESENT ENVIRONMENT

3.1.1 Climate

The Lewistown area's climate is a modified continental type. Average minimum and maximum temperatures are 29.2 and 55.5°F, respectively, as measured at the airport climatological station. The annual precipitation is approximately 11 inches. More detailed climatological data for the Big Spring Creek watershed (including Lewistown) are presented in Section 2.1.2 of the Milestone No. 2 Report (MultiTech, 1983a).

3.1.2 Air Quality

Total suspended particulate (TSP) data was gathered intermittently during 1980-1983 by the Montana Department of Health and Environmental Sciences (MDHES), Air Quality Bureau (AQB). The hivol station was situated on the roof of the Mid-State Bank, located roughly in the center of Lewistown's business district. The results indicate a geometric mean ranging from 40 to 50 $\mu g/m^3$ (micrograms per cubic meter) and 24-hour maximums ranging from 93 to 144 $\mu g/m^3$ (Stan Sternberg, personal communication). The observed levels do not approach the primary National Ambient Air Quality Standards of 75 and 260 $\mu g/m^3$ for annual geometric mean and 24-hour maximum values, respectively.

The major sources of TSP, within the general study area, are fugitive dust released by vehicle travel (especially on unpaved roads) and agricultural activities. Minor amounts of TSP generated by open burning of timber harvest residues are also probable.

3.1.3 Geology

The project area is underlain by Quaternary-aged alluvium. The composition of this material varies, but usually consists of unconsolidated gravel, sand, silt, and clay. Depth to bedrock varies from 0 to 70 feet. Further discussion on the area's surficial geology is presented in Section 2.2.1 of the Milestone No. 2 Report (MultiTech, 1983a).

3.1.3.1 Topography/Physiography

The Judith Basin is an unglaciated depression within the Missouri Plateau; the Plateau is in turn located within the Great Plains physiographic province, (Fenneman, 1931). The topographic and structural basin is enclosed by the Moccasin Mountains to the north, Judith Mountains to the northeast, Big Snowy Mountains to the southeast and south, and the Little Belt Mountains to the southwest and west.

The Big Spring Creek watershed is located in the eastern portion of Judith Basin; see Figure 3-1. It extends 21 miles from Lewistown south to the Big Snowy Mountains. The watershed averages approximately seven miles in width, possesses an average topographic gradient of 230 feet-per-mile, contains

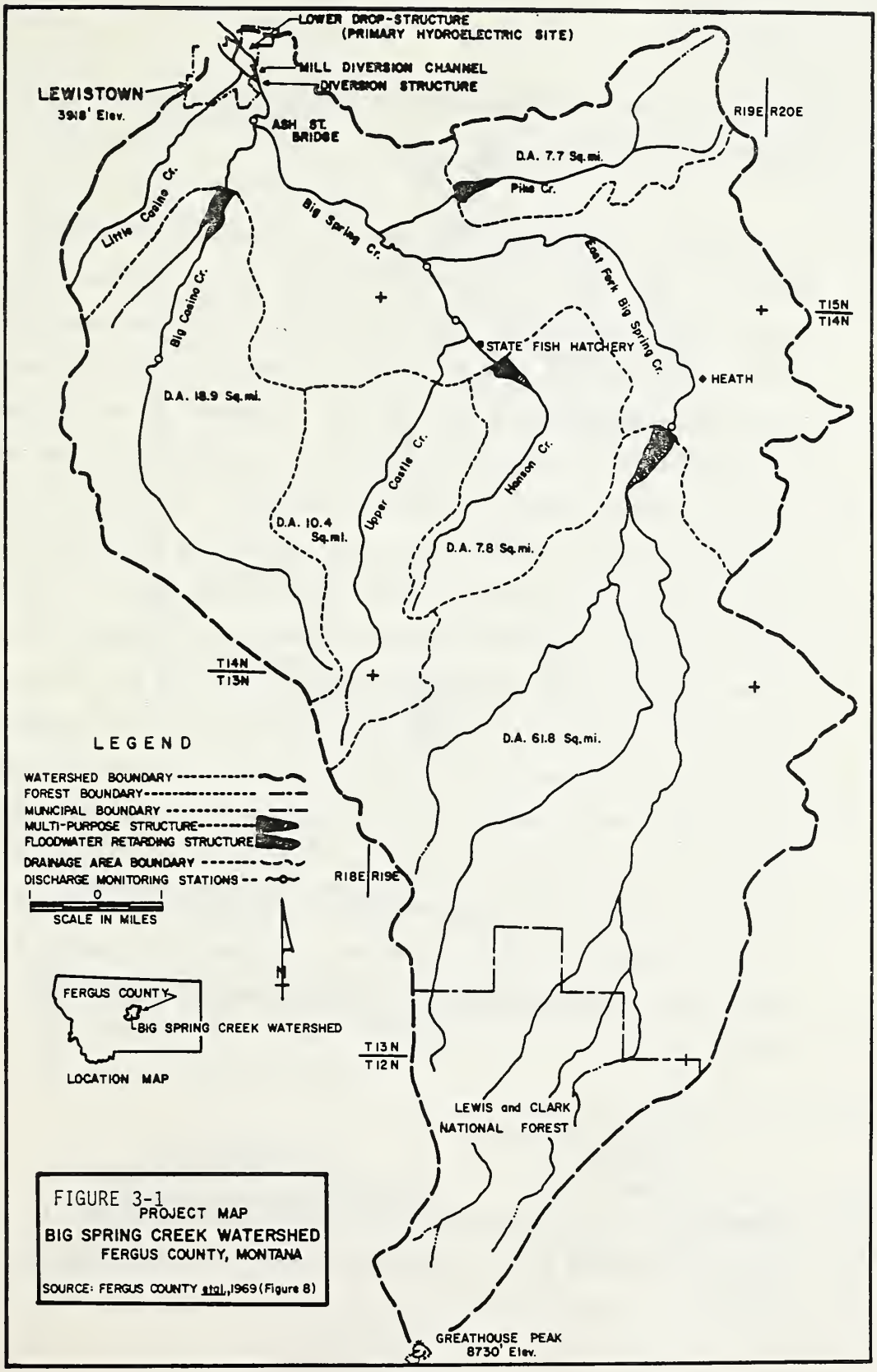


FIGURE 3-1
PROJECT MAP
BIG SPRING CREEK WATERSHED
FERGUS COUNTY, MONTANA

SOURCE: FERGUS COUNTY et al., 1969 (Figure 8)

about 96,000 acres (150 square-miles), and includes most of the City of Lewistown (Fergus County et al., 1969).

The watershed is bounded on the south by the east-west trending Big Snowy Mountains. The crest of the range follows a narrow, sinuous, relatively smooth ridge that generally ranges from 8,000 to 8,500 feet above mean sea level. Greathouse Peak, at 8,730 feet, is the highest point within the watershed. The northeast edge of the watershed is composed of the toe slopes of the northeastward-trending Judith Mountains; elevations within the general study area commonly range from 4,000 to 4,500 feet. The mountain ranges on the eastern boundary of the watershed are connected by a structurally high area, including several small anticlinal domes (Feltis, 1973). The foothills circle the basinward sides of these two ranges and are especially prominent to the north of the Big Snowy Mountains (Feltis, 1973, p. 5). Steep-walled, open canyons have been cut through these limestone beds; the headwaters of major perennial and intermittent drainages are located within these canyons. The relatively smooth, nearly flat to gently sloping surfaces observed within the vicinity of Lewistown constitute the floodplain of Big Spring Creek. It was formed probably from coalescing alluvial fans that spread from the foothills and mountains (located up-gradient from the fans). Gently sloping, gravel-covered terraces also exist adjacent to the present Big Spring Creek floodplain.

3.1.3.2 Surficial Geology

Inspection of Figure 3-2 reveals four surficial geologic mapping units present within the intensive study site area and vicinity. The four demarcated units

LEGEND:

- Approximate Boundary of Lewistown
- Approximate Boundary of Intensive Study Area
- Qal Alluvium (Quaternary)
- Qt Terrace Gravels (Quaternary)
- Kc Colorado Shale ("Transitional" and Upper Cretaceous)
- Kk Kootenai Formation (Lower Cretaceous)
- Strike and Dip (of Strata)

Scale: 1:15,840

0 330 660 1320 1980 2640 feet

FIGURE 3-2

SURFICIAL GEOLOGY MAP FOR THE INTENSIVE STUDY SITE AREA AND VICINITY

Source: L.S. Gardner, 1959

are: Quaternary alluvium (Qal), Quaternary terrace gravels (Qt), "transitional" to Upper Cretaceous Colorado shale (Kc), and Lower Cretaceous Kootenai Formation (Kk). The project area is underlain by Qal, which varies in composition but usually consists of unconsolidated gravel, sand, silt, and clay. Depth to bedrock varies from 0 to 70 feet.

The Big Spring Creek watershed and Lewistown are situated on the eastern boundary of Algermissen's seismic risk zone 2 (Montana Department of Natural Resources and Conservation, 1974). This zone is subject to 50-to-100 year frequency earth movements exerting forces of up to Richter magnitude 5, and being evidenced by Modified Mercalli intensities of VII. Thus, slight to moderate damage may occur to well built, ordinary structures; however, damage to structures of good design and construction would be negligible. Accompanying effects of such earth movements within the project area may include 1) semi-consolidated terrace gravels moving downslope (slight risk due to the low gradient); 2) inducement of landslides or slumping on slopes $\leq$ 30 degrees, especially where underlain by water-lubricated Colorado shale; 3) ground breakage and/or mass movement due to unstable or thixotropic soils (an unexpected event, given the area's soil types); and 4) damage to roads and structures if located over a previously unidentified fault, which has been reactivated by the earth movement (also an unexpected event, given the intensity of geologic studies performed in the study area).

3.1.4 Soils

Eltsac-Lawther, Farnuf and Sudworth-Nesda soil series associations or individual soil series (Weatherford, personal communication) are found at the proposed site.

The three soil mapping units found in the study area have the following substratum (parent material) characteristics: Eltsac-Lawther--having dark gray shale residuum and pale olive to olive-brown silty clay alluvium; Farnuf--yellowish brown clay loam; and Sudworth-Nesda--having light-brown to grayish-brown, very gravelly to extremely gravelly sand to loamy sand. These soils are tentatively assumed to be formed largely from rocks of the Colorado shale Formation. The characteristics of these soil types are described in the Milestone 2 Report. The effects of the soil types on the project are discussed in Section 1.4.3 of this report.

Topsoil will be reapplied to disturbed areas where vegetation is to be re-established during the site clean up/reclamation phase. Care must be taken in salvaging topsoil so as to minimize an acceleration of erosion in the exposed topsoil, thus minimizing elevated sedimentation effects in adjacent/downstream drainage channels. Coarse screening and/or mulching of the salvaged soils may be necessary to create a texture more conducive to the establishment of desirable plant cover.

3.1.5 Hydrology

The Big Spring Creek watershed's principal water-yielding area occurs on the northern flanks of the Big Snowy Mountains. In addition to its namesake, the main tributaries to Big Spring Creek are the East Fork of Big Spring Creek, Hanson Creek, Castle Creek, Pike Creek, and Big Casino Creek.

Big Spring is located in the central portion of the watershed and provides the base flow of Big Spring Creek. Data gathered by the U. S. Geological Survey (USGS) shows an annual average discharge of 107 cubic feet per second (cfs) for water years 1932 through 1957. Annual and monthly averaged summaries reveal a relatively constant discharge from the spring, as measured approximately one-half mile downstream of the source. From 1932 to 1968 the minimum observed discharge was 76 cfs in February 1938, and the maximum observed discharge was 250 cfs observed in June 1967 (R. D. Feltis, 1973). The Hanson and Castle Creek tributaries drain rangeland and cropland areas in the lower foothills of the watershed. Their flow contributions, in conjunction with the Big Spring flow, collectively forms the headwaters of Big Spring Creek.

The USDA Soil Conservation Service (SCS) designed and constructed a multi-purpose structure on Hanson Creek in the mid-1970s, located approximately one-half mile upstream from the Montana Department of Fish, Wildlife, and Parks (DFWP) Fish Hatchery. The maximum discharge of the principal spillway is 76 cfs.

The high-flow 25-year recurrence interval for Big Spring Creek varies from slightly less than 100 cfs to approximately 190 cfs; most discharge levels are less than 175 cfs, when observation periods of at least 60 days are considered. Given that a first-magnitude spring (i.e., discharge $\geq$ 100 cfs) sustains this stream flow, the recurrence curves are nearly flat, especially for intervals of three years or less. The short-term (seven-day) peak flow in June often exceeds 175 cfs, and represents rainfall effects plus snowmelt runoff from the high mountain snowpack. Conversely, the cavernous Madison

limestone acts as a recharge area for the Big Spring, and maintains largely a constant groundwater flow to the spring. Thus, the low-flow 25-year recurrence interval is usually 100 cfs, while the seven-day minimum sinks below 80 cfs every 20-to-25 years (R. D. Feltis, 1980).

Big Spring Creek flows through the Montana Department of Fish, Wildlife, and Parks (DFWP) Fish Hatchery, then continues northerly to northwesterly to Lewistown. As it passes through town, a diversion structure on the southeast side of Lewistown divides the flow between the main channel and the Mill Diversion Channel (MDC).

The headwaters of East Fork Big Spring Creek occur in a large, timbered basin near the base of Greathouse Peak. The East Fork drains the south and east portions of the watershed, meanders through broad valleys along the foothill area, and joins with Big Spring Creek approximately two miles below the DFWP Fish Hatchery (Fergus County et al., 1969). In the mid-1970s, a multipurpose structure was designed and constructed by the USDA Soil Conservation Service on East Fork Big Spring Creek, approximately 11 miles southeast of Lewistown. The reservoir has capacity for floodwater detention; it also provides recreational waters and sediment retention. Discharge from the reservoir has been monitored for water years 1975-1981 by the SCS. Additional discharge data has been gathered on the East Fork downstream of the reservoir, but above the confluence with Big Spring Creek.

The data from these monitoring stations show that, on the East Fork Big Spring Creek, the following conditions prevail: 1) minimal discharge values occur largely in January and begin to increase by late February or early March due

to snowmelt runoff at lower elevations; 2) the continuing increase in reservoir discharge and stream flow during April and early May is due largely to runoff from snowmelt and precipitation from the foothills (R. D. Feltis, 1973); 3) the peak flows occur from late May through mid-June, due largely to peak rainfall during these months acting in combination with snowmelt runoff from the north-facing, upper flanks and peaks of the Big Snowy Mountains; and 4) the rapid decline in discharge is due to relatively low, but stable, levels as the seasons progress from early summer through early winter.

Pike Creek drains a 7.7 square-mile, grass-covered upland area southeast of Lewistown; the creek flows to the west and joins with Big Spring Creek approximately two miles above Lewistown (Fergus County et al., 1969). A flood detention structure has been designed and constructed by the SCS on this Creek. The maximum capacity of the principal spillway is 70 cfs. Occasional staff gage readings and a pool elevation reading for the period of August 1977 through June 1982 have been acquired from the Bozeman SCS office.

Big Casino Creek drains the west portion of the watershed. The upper reaches consist of grass-covered, moderately steep rolling foothills and flat high terrace deposits. The lower portion of Big Casino Creek flows through outlying residential areas on the south side of Lewistown, and joins Big Spring Creek near the southern limits of the City (Fergus County, et al., 1969). The USDA SCS designed and constructed a flood retention dam on the creek in the mid-1970's, approximately one and one-half miles south of Lewistown. The maximum discharge from the principal spillway is 124 cfs (Fergus County, et al., 1969).

3.1.6 Water Quality

Big Spring Creek is characterized by hard, calcium bicarbonate-type waters (Kaiser and Botz, 1975). The MDHES, Water Quality Bureau (WQB) has classified the stream as being B-1 waters above the Mill Ditch headgate; the stream is classified as B-2 downstream of the headgate to the confluence with the Judith River (ARM 16.20.601 through 16.20.643). Turbidity, temperature, dissolved oxygen, and organic contaminant standards for these two classifications are presented in Table 3-1. These parameters are important in assessing impacts potentially arising from implementation of the MDC hydropower project (Loar and Hildebrand, 1980).

Selected water-quality parameters were determined at sampling sites located upstream or downstream of Lewistown. As the sites varied from one study to another, only generalized "upstream" vs. "downstream" comparisons can be made (per given parameter). The two pollutants of concern upstream of Lewistown are suspended solids and nitrate levels. Headwaters silt loading may arise from inappropriate logging and agricultural practices and from subdivision construction activities (MDHES, WQB, 1980). Nutrients may be emanating from the trout hatchery and from septic tank seepages (Kaiser and Botz, 1975). Regarding "downstream" water quality, aquatic life and recreational uses are being impaired by eutrophication and sedimentation processes. The nutrient (e.g., ammonia-phosphate) loadings are probably originating from wastewater treatment plant effluents and from irrigation return waters (to Big Spring Creek). Other downstream impairments to water quality include natural stream-bank erosion, accelerated erosion from cultivated fields or overgrazed range-lands, and from saline seep (MDHES, WQB, 1982).

TABLE 3-1.--PERTINENT POLLUTION CONTROL STANDARDS FOR CLASS B-1 AND B-2 WATERS IN MONTANA

Parameter	Water Classification B-1	B-2
Turbidity	Maximum allowable increase above naturally occurring levels is 5 nephelometric turbidity units (NTU), except where short-term construction or rehabilitation activities are authorized by the WQB.	Maximum allowable increase above naturally occurring levels is 10 NTUs, except where short-term violations are authorized (by permit) by the DHES, WQB.
Temperature	A 1°F maximum increase above naturally occurring water temperature is allowed within the range of 32°F to 66°F.	Same "increased temperature" standard as for B-1 waters. A 2°F per hour maximum decrease below naturally occurring water temperature is allowed above 55°F. A 2°F maximum decrease below naturally occurring water temperature is allowed within the range of 55°F to 32°F.
"Organic Contaminants"	No increases above naturally occurring concentrations of sediment, settleable solids, oils, or floating solids, which adversely affect the use indicated, are allowed.	Same standard as for B-1 waters.
Dissolved Oxygen (D.O.)	D.O. concentration is not to be reduced below 7.0 mg/l.	D.O. concentration is not to be reduced bwlow 7.0 mg/l from October 1 through June 1, nor below 6.0 mg/l from June 2 through September 30.

Source: Administrative Rules of Montana (ARM), 16.20.618; No. 20.619.

3.1.7 Vegetation

Although no quantitative data was gathered, the MDC diversion/headgate area appears to be a disturbed foothills-grassland community type. Native grass species probably include western wheatgrass, green needlegrass, prairie junegrass and Sandberg bluegrass; native forbs probably include Western yarrow, lupine, and phlox (Payne, 1973; Ross and Hunter, 1976). Disturbed site and weedy species probably include cheatgrass brome, threadleaf sedge, knapweed, and pussytoes (Payne, 1973; Ross and Hunter, 1976).

The hydropower generating station site is parkland (Poa species), owned and maintained by the City of Lewistown. A small clump of riparian vegetation (e.g., willows) exists within the area to be occupied by the MDC headgate bypass structure (MultiTech, 1984). This community type is well represented at the proposed fish barrier site, downstream of the hydropower station and near the confluence with the natural channel of Big Spring Creek (MultiTech, 1984). Although no quantitative data was gathered, the overstory is dominated by plains cottonwood, while various willow, rose and chokecherry species probably dominate the understory (shrub) layer (Ross and Hunter, 1976). The graminoids probably include sedges, prairie cordgrass, slender wheatgrass and reedgrass species.

No rare, endangered or threatened plant species have been found within the project area (Lesica et al., 1984). The fact that heavy disturbance by industrial and construction activities has occurred in areas encompassing and adjacent to the MDC reinforces the unlikelihood of these plant species occurrence.

3.1.8 Wildlife

The project area is situated on the edge of the commercial/light industrial district of Lewistown and has been heavily disturbed by human enterprise. Therefore, big game and upland game bird habitat is virtually nonexistent. However, the proximity of rangeland/cropland and forested areas may be sufficient to allow occasional appearance of pronghorn antelope, whitetail deer, ring-necked pheasant, and Hungarian partridge (Mussehl and Howell, 1971). Small mammal (e.g., mice, rabbit) species are most likely common in the area. Thus, various raptors (e.g., ferruginous hawk, prairie falcon) may utilize the area for feeding.

It is extremely unlikely that any of the rare, threatened, or endangered species protected by federal statute(s), etc., exist presently within the project area. The duration, magnitude, and intensity of habitat disturbance precludes any continuous use of lands at or near the proposed hydropower generating site by such species. A similar argument is offered for the lack of small mammals of special interest or concern to the State of Montana (Flath, 1981).

3.1.9 Aquatic Vegetation

The periphytic algal community is dominated by *Cladophora*, a long, filamentous green algae. Significant (by volume) bluegreen algal genera include *Oscillatoria*, *Lyngbya*, and *Phormidium*. A colonial plant-like flagellate of the genus *Hydrurus* is also common. The periphyton and dictom community composition and diversity indicates that marginally eutrophic conditions are occurring downstream of Lewistown (Bahls *et al.*, 1981).

Various sedge, rush, and fern-like species (e.g., Equisetum) probably compose the "boundary" between the riparian and aquatic zones. Emergent and lentic genera probably include Typha and Lemna, respectively.

3.1.10 Aquatic Wildlife

The macroinvertebrate community of Big Spring Creek has been sampled intensively by the MDHES-WQB (Bahls et al., 1981). Taxonomic enumeration of samples taken from above and below the MDC, during August 1982, are presented in Table 3-2. The decrease in Trichopteran (caddisfly) populations and increase in Dipterans (true flies) downstream of the Montana Power site may indicate an increase in organic pollutants or oxygen-demanding pollutants. The total numbers of invertebrates collected during the 1981 and 1982 field seasons--4708 and 4563, respectively--were less than half the presently maximum value of 9488 collected in 1980 (Poore, 1983a). The decrease in total numbers is probably in response to sustained high flow conditions, particularly during spring runoff in 1981. Evidence continues to indicate that flushing and scouring action is the primary limiting factor for invertebrate production in Big Spring Creek. However, two years were required after the devastating flood of 1975 for benthic macroinvertebrate populations to return to "pre-flood" numbers (Poore, 1983b). Thus, increases in total numbers over time is expected, barring any catastrophic flooding in the near future.

Rainbow trout and brown trout are the principal game fish present within the study area. The population characteristics of these two species are discussed in Appendix A (Table 1-2) of Milestone Report No. 4, (MultiTech, 1984). It

TABLE 3-2.--TAXONOMIC ENUMERATION OF BENTHIC MACROINVERTEBRATE SAMPLES COLLECTED ABOVE, ADJACENT TO, AND BELOW THE MDC/PROJECT AREA

Taxonomy	"ABOVE" (Montana Power Site)	"ADJACENT TO" (St. Leo's School)	"BELOW" (Above Sewer)
Trichoptera			
Brachycentridae	227	146	88
Leptoceridae	138	8	17
Rhyacophilidae	149	44	10
Hydropsychidae	2	2	2
Hydroptilidae	40	154	9
Psychomyidae	-	-	1
Limniphilidae	-	-	1
Helicopsychidae	-	-	-
Gastropoda			
Physidae	3	-	7
Planorbidae	4	-	1
Diptera			
Tipulidae	10	44	30
Tendipedidae	30	35	97
Rhagionidae	-	-	-
Empididae	-	1	-
Simuliidae	13	2	19
Tabanidae	-	-	-
Muscidae	-	-	-
Tricladida			
Planariidae	-	-	-
Ephemeroptera			
Baetidae	38	15	165
Heptageniidae	4	2	2
Plecoptera			
Perlodidae	-	-	-
Perlidae	-	-	-
Chloroperlidae	-	-	-
Oligochaeta			
Annelidae	-	-	-
Pelecypoda			
Sphaeriidae	1	-	2
Coleoptera			
Elmidae	8	7	1
Hydracarina	9	5	-
Nematomorpha			
Chordodidae	4	-	1
Nematoda	5	-	-
Cladocera	-	-	-
Station Totals	685	465	462
Org. No./Sq. Foot	342	232	231
No. of Families	17	13	18

Source: Poore, 1983b.

is unlikely that any of the amphibian, reptile, or fish species listed as endangered or threatened (45 Federal Register 99:33767-33781; May 20, 1980) exist within the project area.

The MDFWP has identified four fish species of special concern as possibly residing, or known to reside, within Fergus County. These species are pallid sturgeon, paddlefish, finescale dace and sicklefin chub (Flath, 1981). All but the dace are probably excluded from the project area due to lack of suitable habitat (Holton, 1980). The finescale dace prefers small clear streams and ponds, and may reside in the area as a hybridized form (Brown, 1981).

The common snapping turtle (Chelydra serpentina) and spiny softshell turtle (Trionyx spiniferus) are reptilian species of special interest or concern to the MDFWP (Flath, 1981). The former species prefers habitat "where aquatic plants are abundant and where there is a soft bank or bottom for hibernation and hiding," (Black, 1970, p. 27). The spiny softshell appears to favor "waters with a bottom of gravel, sand, silt, or mud," (Black, 1970, p. 30). Either or both of these habitats probably exists within the general project area. Therefore, efforts should be made to verify the presence or absence of these species within the affected area prior to project implementation.

3.1.11 Human Environment

Useful socioeconomic data for Lewistown can be found in a comprehensive plan prepared by Clark, Coleman, and Rupeiks, Inc. (1971). Overall, project implementation will have negligible adverse effects, and possibly significant beneficial affects, on the area's human environment.

The greatest issue revolves around changes in land use. The three major land use categories present within the project area are "green space," "commercial," and "low density residential," (Clark et al., 1971). The public and quasi-public green belt-open space zone is situated adjacent to portions of Big Spring Creek and the MDC. Both of these channels pass through or by portions of the central business district and light industrial (e.g., warehousing/grain elevator) operations. Single-family dwellings occur adjacent to both of the channels as they traverse through town. A small tract of rangeland exists directly east of the MDC, being located approximately 1500 feet south-southeast of the proposed generating station.

3.2 IMPACT ASSESSMENTS

This section presents a general assessment of potential impacts on the study area's natural environmental and socioeconomic conditions, arising from project implementation. The significance of the identified beneficial or adverse effects has been evaluated on the basis of preliminary engineering design and related plant siting data. Thus, the resource-specific analyses (and conclusions) may be modified somewhat as more detailed planning information becomes available. Information contained in the various milestone reports prepared to date provides sufficient information for preparation of the formal Preliminary Environmental Review (PER) by the State of Montana, et al.

3.2.1 Climate

Any dust generated during construction that becomes suspended in the atmosphere would contribute to the atmospheric dust load. Given the short-term and minimal requirements for excavation and earth moving activities, negligible effects are envisioned on the project area's atmospheric heat balance and precipitation pattern. Furthermore, hydropower facility operations will not likely exert any long-term adverse or beneficial effect on the project area's climatic conditions.

3.2.2 Air Quality

Construction equipment and other motorized vehicles will emit various air pollutants, including nitrogen oxides, carbon monoxide, sulfur oxides, hydrocarbons, and particulates. As such emissions are regulated by law, only in the worst case would one expect even minor, local, impacts on air quality. Open burning of solid wastes generated during site preparation or construction phases will not occur on-site (if at all).

Respirable dust particles will be raised occasionally by traffic passing along dirt- or gravel-surfaced roads, and by heavy equipment operations. Given dry, windy conditions short-term (and intermittent) degradation of air quality within 100 feet from construction/excavation sites could occur. Passing vehicles and equipment operation would entrain the pulverized surface particles, with the cross-winds carrying the subsequent fugitive dust plume(s) into adjacent areas. These plumes could be a nuisance to nearby residents, motel occupants, and construction workers. Overall, these concerns are

judged to be of minor concern. The types and frequency of traffic occurring throughout the project's duration will not be significantly different than those utilizing the existing road system at present. Furthermore, favorable meteorological conditions (e.g., light rainfall) and common engineering practices (e.g., watering or paving) will mitigate largely such potentially adverse impacts on "baseline" air quality. The operating hydropower (and fishway) facilities will not have a significant impact on baseline air quality conditions.

3.2.3 Noise

The transport of construction materials along various access routes, plus site preparation and construction activities (possibly at several sites) will exceed the presumed daytime "baseline" noise levels of 50-55 dBA. Sound intensities produced by stationary, materials handling, earthmoving, and impact (e.g., jackhammer) equipment will range between 70 and 95 dBA, as measured at 50 feet from the source (USDI/BPA, 1974). Despite the use of noise mufflers and natural attenuation processes, off-site sound levels (e.g., as measured at the Yogo Inn) may vary from 60 to 65 dBA.

Sound intensities of 65-70 dBA can interfere with normal conversation and telephone useage; levels from 80-90 dBA are annoying, and may cause permanent hearing impairment (if exposed to such intensities on an 8-hour, long-term basis). Fortunately, worker exposure to time-weighted sound levels exceeding 90 dBA (per 8-hour shift) are prevented by OSHA regulations.

Although construction-related noise will be short-term (probably three to four weeks) and be limited to "daylight" hours, some complaints may be received from individuals residing in the area who sleep during the day (Von Gierke et al., 1977). However, the noise levels which are expected to occur at the entrance to the Yogo Inn will not exceed those observed in an urban environment. Given that noise emissions can be mitigated to tolerable levels, noise effects are judged to be of minor concern.

The operating facility may exceed "baseline" noise levels slightly (e.g., to 55 dBA), as measured at the respective property boundaries. The principal emission source will be from the turbine discharge-stilling basin area. This increase in noise levels, even at night, is judged to be insignificant.

3.2.4 Geotechnical Constraints on Engineering Design

The potential geoedaphic constraints to project implementation are discussed in the Milestone No. 2 Report (MultiTech, 1983a). The Eltsac-Lawther soil association present in the hydropower station area is characterized by moderate water erosion and high wind erosion hazards. The high clay content of these soils results in high (possibly adverse) shrink-swell potential, medium run-off rates and very slow moisture permeability (<0.06 0.2 in/hr), plus exhibit moderate concerns regarding sidewall stability, excavation and compaction properties. The Farnuf loam, occurring at the headgate bypass site, is characterized by high water erosion and moderate wind erosion potential. Shrink-swell ranges from low-to-moderate, corrosivity ranges from high-to-low (for steel vs. concrete pipe, respectively), while frost action is moderate.

The proposed conduit must be well-sealed, or leaks could result in severe "piping" problems. Overall, the small areal extent and duration of disturbance, coupled with common engineering design and operation practices, should minimize the potentially adverse effects of the above soils properties.

It is not likely that any major fault system exists within the project area. However, Lewistown could experience an earth tremor of Richter magnitude 5--evidenced by Modified Mercalli intensities of VII--once every century, (Multi-Tech, 1983a). Thus, slight to moderate damage may occur to well-built, ordinary structures. Damage to structures of good design and construction would be negligible.

3.2.5 Soils

The location of well-engineered hydropower and ancillary facilities, plus implementation of cost-effective mitigating measures, will not prevent completely adverse effects from occurring on the project area's soil resources. Despite careful planning and implementation efforts, highly localized and short-term adverse effects resulting from accelerated wind and/or water erosion are possible. The major causes of such erosion, especially of the topsoil, are as follows:

- Disturbance, if not complete removal, of vegetation within the fish bypass, and hydropower generation site rights-of-way;

- Construction practices that increase slope length and/or gradient, especially on highly erodible, naturally steep slopes;

- Compaction of soils (especially if wet) along the rights-of-way and on temporary access roads. A decrease in (soil) pore volume would decrease moisture holding capacity, subsequently increasing runoff rates;

- The use of unpaved access roads will result in pulverization of the surface particles, with subsequent loss as "fugitive dust"; and

- The possible mixing of soil horizons during the back-filling around the bypass, fish ladder, and hydropower station will affect such soil properties as porosity, permeability, and fertility (e.g., organic matter content, pH).

A rigorous quantification of the areal extent and duration of accelerated erosion rates (arising from the above activities) was not attempted. However, successful mitigation efforts could limit such rates to several fold of those now occurring, and for periods of one to several years following completion of construction activities. The total areal extent of significant disturbance will be less than 0.25 acre.

3.2.6 Groundwater

Excavations made during the construction of the power plant and fishway may intercept shallow groundwater aquifers. Under "worst-case" conditions, excavation dewatering temporarily could lower the local water table. The impact of such a drawdown would be negligible, given the short duration of pumping.

It is possible, but not likely, that various hydrocarbons (e.g., diesel fuel, oil-grease, and solvents) spilled or leaked during construction could infiltrate shallow groundwater aquifers. However, the project size and duration is such that -- even for the envisioned "worst case" -- only short-term, local degradation of water quality would occur.

A number of the MDC sidewall-drainage ducts (or "weep holes") will be inundated by the power station's pool (located behind the weir gate). The surface elevation of the power pool will exceed ordinarily that elevation observed for the groundwater. Thus, water would leave the MDC, causing a local rise in the water table (adjacent to the channel). The USDA/SCS has recommended that trial damming (and observation of groundwater response) be scheduled during the final engineering design phase (Smith, personal communication). However, as no thermal or chemical stratification is expected in the power pool, any water seeping into the groundwater should not alter significantly the latter's baseline properties.

3.2.7 Surface Water

The Montana Department of Fish, Wildlife and Parks (MDFWP) currently possesses an instream flow right of ~ 115cfs, on upper Big Spring Creek (Poore, personal communication). The MDFWP has also estimated that 35 cfs is necessary to maintain aquatic habitat, etc., in the natural channel--as it flows through Lewistown. The generation of hydroelectricity at the lower drop structure represents a non-consumptive use of the flow within the MDC; furthermore, plant capacity recognizes the need to allocate 35 cfs to the natural channel.

Therefore, no adverse effects to existing water rights, or to aquatic biota, arising from project implementation are expected.

Construction of the hydropower and ancillary facilities could result in short-term increases in surface water turbidity and sediment transport. The major sources of sedimentation are runoff from excavation and/or cleared construction sites. The cumulative sedimentation rate may exceed temporarily the Montana State turbidity (water quality) standard for B-2 waters. In such a case, the Montana Department of Health and Environmental Sciences (MDHES) will require a permit prior to proceeding with project construction (Multi-Tech, 1983c).

Short-term contamination of surface waters by various hydrocarbons during the construction phase is possible. These substances include hydraulic fluid, lubricating oils, coolants, and diesel fuel leaked or spilled from construction equipment and personal vehicles. In addition, appropriate control of sanitary waste and construction solid wastes must occur to prevent degradation of water quality.

As the facility will be operated in a "run-of-the-river" mode, a number of water quality problems associated with reservoir-type operations will be eliminated, or rendered insignificant.

3.2.8 Vegetation

Construction and operation of the hydropower station and fishway will eliminate--for the project's duration--approximately 0.1 acre of parkway lawn

(*Poa* species). An adjacent area (<0.1 acre) will be disturbed by construction activities, and may require reseeding or the installation of new sod.

Similarly, the bypass system will modify, if not destroy, approximately 0.04 acre of riparian/rangeland communities; this effect is judged to be biologically insignificant. However, accelerated erosion/sedimentation effects on the Big Spring Creek must be avoided via slope stabilization and appropriate revegetation efforts.

3.2.9 Wildlife

Those vertebrate (e.g., small mammal) species either living within, or utilizing, the project area may be affected adversely--by direct mortality or displacement--as a result of project implementation. The biological significance of these occurrences will be mitigated by the inherent fecundity of most of these species. Re-establishment of these populations will be aided by restoration (if not improvement) of baseline habitat conditions, during the reclamation phase.

3.2.10 Aquatic Vegetation

The "run-of-the-river" operations should not affect the Big Spring Creek's baseline hydrologic or water quality characteristics. Instream disturbance at the bypass (and possibly barrier dam) site(s) will involve very small areas (e.g., 0.02 acres). Therefore, "worst-case" impacts to the area's periphyton or macrophyte communities will be minor.

3.2.11 Aquatic Wildlife

The "run-of-the-river" operations will not affect significantly the existing benthic macroinvertebrate community, as no changes from baseline hydrological or water quality conditions are expected.

The most significant environmental issue is the enhancement of Big Spring Creek game fishery resources. One of the potential benefits of this project identified by Fergus Electric Cooperative before the study began was the improvement of fish migration through the flow structures in Lewistown. As presently structured, fish are attracted to the MDC in preference to Big Spring Creek due to higher flow volumes and velocities associated with the MDC as it joins Big Spring Creek. However, the drop structure in the MDC presents an insurmountable barrier to most of the fish, and the gate at the head of the MDC further prevents passage of those fish that have travelled that far. At the direction of Fergus Electric Cooperative, and with the concurrence of the Montana Department of Fish, Wildlife, and Parks and the City of Lewistown, two options have been developed to remove these hinderances to upstream migration. These options and the proposed vertical slot fishway at the drop structure in particular are discussed in Section 4.0 of Milestone No. 4 Report, and in Section 1.5 of this report.

3.2.12 Human Concerns

3.2.12.1 Public Attitudes

To date, local sentiment appears to be generally neutral towards the hydropower project. However, the local rod-and-gun club has offered support for the fisheries improvement (fishway) concept. The residents of Lewistown probably will recognize that the expanded revenue base (including possibly that received from tourism) far outweighs any short-term inconveniences created by project implementation.

3.2.12.2 Economic Impacts

Construction will stimulate the local economy. The process may utilize a local contractor, and create ~6 temporary jobs. Some local purchases of building materials, equipment, etc. will occur. Favorable indirect, or "derivative", effects induced by project and worker expenditures will also occur.

The direct, long-term beneficial effect will be energy revenues. An indirect effect will be the provision of reliable renewable energy into the Montana Power Company's (MPC) generation-transmission system, at rates which will not exceed avoided-cost.

As the facilities probably could be owned by a taxable entity (but probably maintained jointly with the City), some shared revenues from power generation and property taxes are possible. Increases in personal taxes coming from

construction personnel will be insignificant, while no long-term increases are envisioned--given the lack of new, permanent jobs created by this project. Supervisory and maintenance personnel will be provided by the City of Lewistown.

3.2.12.3 Population Impacts

Construction-related labor probably can be filled from the local area. Furthermore, no permanent employment will be created by this project. Therefore, no changes in the baseline population base, due to project implementation, are expected.

3.2.12.4 Public Service Impacts

The absence of population increases eliminates concern over increased demand for general government services (e.g., law enforcement, fire protection). Increased short-term maintenance of the local road system may be necessary. Although construction-related vehicles will not exceed road limits (i.e., regarding vehicle weight, width, and length), increased road use will contribute slightly to its deterioration. The combination of short-term traffic congestion, control of fugitive (roadway) dust, plus concern for the safety of construction workers and local residents will require appropriate maintenance of, and traffic control on, the affected roads.

The long-term impact of the hydropower system will be positive. Those revenues paid to the City could be utilized to expand or improve municipal

services without raising local property taxes. Following completion of construction, the system would create no appreciable demand for public services. However, a contingency fund for handling potential emergencies (e.g., equipment damage due to flooding or excessive ice-loading events) should be considered.

3.2.12.5 Private Service Impacts

Minor, albeit beneficial, impacts on the local economy would occur during the project's construction phase. The benefits accrued from wages passing through the private (business) sector, and monies received from purchase of certain equipment, building supplies, etc., will aid the local economy. Overall, the perceived demand for most of the required goods and services can be met locally, without disruption of "baseline" economic and social patterns.

3.2.12.6 Energy Consumption and Related Development

Petroleum product wholesalers will have no problem in supplying diesel fuel, gasoline, and lubricants to construction equipment and associated personal vehicles. As the rated (generation) capacity is small, project implementation will not be a sufficient inducement for siting of new energy-intensive industry within the county. However, the operating system would provide an example of environmentally benign, cost-effective means of electric power generation using a renewable resource.

3.2.12.7 Land Use Issues

Ownership: The project will affect lands owned by the City of Lewistown. Prior to construction, conflicts between this project and any existing or proposed resource management-development plan will be resolved.

Land Use: Previously, interest has been expressed regarding a broadened industrial base. Such development must be compatible with appropriate performance standards (e.g., noise, vibration, glare) and other zoning controls, such as landscaping, (Clark et al., 1971). The hydropower station site will be located within the City's commercial/light industrial business district. Fergus Electric Cooperative will cooperate with the City-County Planning Board to assure compliance with those regulatory measures pertinent to project design and implementation.

The hydropower and associated facilities will be of sufficiently small scale that adverse effects on existing or potential commercial or light industrial developments will be negligible. The two effects foreseen are:

- Exclusion of alternate land uses within, and somewhat adjacent to, the MDC right-of-way during the construction and reclamation phases; and

- Exclusion of alternate land uses at the hydropower station site, the fishway system(s) and certain access roads for the project's duration.

The areas to be disturbed by project implementation are not currently (and probably never will be) utilized for agricultural purposes or for other natural resource-type developments. Hydropower facility construction and maintenance could constitute a nuisance to sensitive residents residing adjacent to the project area. It is not likely that project implementation would interfere with suburban (residential) growth or existing recreational opportunities adjacent to, or within, the project area.

Visual Resources: The project area lies within gently sloping to nearly flat terrain that has been heavily disturbed by human activities. Even under "worst case" conditions, only short-term, slight-to-negligible adverse aesthetic impacts will occur. The combination of noise, dust and presence of heavy equipment operations may annoy some local residents and other persons passing by (on State Highway 87) the project site. New structures will be introduced onto the landscape, and small areas of denuded soil will be exposed until revegetation efforts take effect.

Cultural Resources: The project area lies within the previously established right-of-way for the MDC. It is therefore likely that any near-surface archaeological, historical or paleontological site has been previously recovered or destroyed. However, previously undiscovered sites or objects may exist at depth or in potentially disturbed areas situated adjacent to the present right-of-way. To address these concerns, Fergus Electric Cooperative will maintain appropriate project oversight (i.e., over contractor activities) and maintain contacts with Montana State Historic Preservation Office personnel in Helena.

3.3 PROPOSED MITIGATING MEASURES

This section presents tentative measures to mitigate, if not eliminate, the resource-specific impacts discussed in Section 3.2. Many of the mitigating measures presented (here) are of a generic nature, given the present status of engineering (facility) design. Thus, refinement in environmental assessment and subsequent mitigating measures proposed will parallel progress made regarding engineering aspects of this project. Only environmental phenomena requiring impact mitigation are discussed.

3.3.1 Air Quality

As heavy equipment, personal vehicles, etc., will be operated in accordance with manufacturer's requirements, combustion by-product emissions will be at legally acceptable levels. The amount of fugitive dust generated by project activities can be minimized via use of the following control measures:

- Use existing roads as much as possible, respecting road (haulage) and speed limits as set by law;
- Limiting the frequency and duration of travel on fine-textured, dry soils; and
- Application of effective reclamation practices (e.g., wind erosion control) and fugitive dust suppression methods (e.g., watering of roads within the project area).

3.3.2 Noise

A short-term increase in noise levels (relative to "baseline" conditions) is expected during the construction phase. The consequences of such a rise can be mitigated as follows:

- Reduce the exposed human population of concern by minimizing the area affected by, and duration of, construction activities; plus
- Reduce on-site effects by proper operation of well-maintained equipment, plus enforcement of applicable worker health and safety regulations. Heavy equipment engines will be muffled as practicable. Workers exposed to noise levels exceeding 80 dBA (per 8-hour shift) should be issued hearing protection devices.

Turbogenerator noise can be reduced using several commonly employed techniques: 1) the installation of noise and vibration dampening devices; 2) insulation of the (inside) walls and ceiling of the station (prefabricated) building, and 3) planting of shrubs around the perimeter of the station.

3.3.3 Geology and Soils

General guidance regarding the avoidance of geologic and soil constraints is discussed in Section 1.4.3 of this report. All reasonable efforts will be made to mitigate those unavoidable impacts addressed in that section. Control measures offered are discussed in Section 3.4, "Engineering-Related" mitigation.

3.3.4 Groundwater

It is possible, but not likely, that excavation activities could intercept shallow groundwater systems. In such a case, discharge(s) from the dewatering pump(s) may need to be directed to a settling basin, prior to discharge into the particular surface (water) channel.

Prompt isolation and appropriate removal (or treatment) of any spilled hydrocarbon or other biologically toxic substance will mitigate any potential impact on the area's groundwater quality.

3.3.5 Surface Water

One of the most significant concerns regarding project implementation is the prospect of accelerated erosion, subsequently increasing sediment load in Big Spring Creek. To minimize long-term sedimentation effects, the following (generic) control measures should be considered:

- During the final location of all project structures, a qualified engineer or hydrologist will identify and demarcate hydraulically unstable stream banks and/or stream channel segments. Such areas will be avoided to the greatest extent possible.

- Any segment of stream channel disturbed during construction or operation (e.g., BSC/headgate fisheries bypass system) should be restored approximately to "baseline" channel morphology and hydraulic gradient conditions.

- Any segment of stream bank disturbed during construction should be appropriately stabilized (e.g., by riprap, revegetation).

- Increases in surface runoff rates at nonriparian areas should be minimized via use of appropriate engineering design and reclamation practices (e.g., reseeding of denuded construction sites).

Potential degradation of surface water quality can be avoided largely as follows:

- Apply appropriate isolation and/or treatment methods promptly after spill of some biologically toxic substance;
- Avoid introduction of construction-related wastes into surface waters; and
- Avoid disturbance of the stream channel, stream bank, and riparian zone to the greatest extent allowed by the engineering plans.

3.3.5 Vegetation

Appropriate reclamation practices will be applied concurrently with, or at the conclusion of, construction activities. Initially, all disturbed areas will be compacted, recontoured, or regraded as appropriate. Appropriate amounts of the pertinent grass-forb seed mixture will then be applied at the headgate bypass area. The particular seed mix plus means and timing of application will be determined in consultation with local Soil Conservation Service personnel. Reseeding or sod placement will occur at disturbed sites surrounding the power station and fishway facilities.

3.3.7 Wildlife

Appropriate revegetation of disturbed areas surrounding the headgate (fisheries) bypass site could improve upon "baseline" habitats for various small mammal and avian species. Reclamation efforts, coupled with inherent population resiliency(ies), should result in return to pre-construction conditions within several years following disturbance.

As mentioned in Section 3.1.8, it is extremely unlikely that any rare, threatened, or endangered species exist within the study area. Prior to final location of the various facilities, a qualified animal ecologist or wildlife biologist should verify the presence or absence of these particular species within the potentially affected project area.

3.3.8 Aquatic Vegetation

Restabilization of affected stream banks should include revegetation components; the revegetated areas would approximate the baseline plant communities (existing prior to project implementation). The seeding and sprigging rates, manner of planting, fertilization, etc. will be determined in consultation with Soil Conservation Service personnel and other reclamation experts.

3.3.9 Aquatic Wildlife

Fish handling systems have been evaluated to enable fish migration past the present obstructions. The dam structure is proposed to be placed at the drop structure, thus further preventing fish passage, so a fish ladder system is

recommended at that point. To enable passage at the MDC headgate a pool and weir, or an Alaska steeppass system would be workable. At the headgate for the Big Spring Creek an open channel or an "Oregon ladder" would be satisfactory. Both the fish passage systems at the drop structure and the headgates are described in greater detail in the Milestone 4 Report and Section 1.5 of this report.

3.3.10 Human Concerns

It is suggested that Fergus Electric Cooperative (FEC) release occasional status reports via press release(s), and encourage the City of Lewistown to hold public hearings at key points in the decision-making process. Such a hearing could be held following FEC's decision to implement the project but prior to official approval by the Federal Energy Regulatory Commission. Any adverse opinions gathered by these means could be mitigated (to the extent possible) during the final planning/permitting efforts. The press release-hearings mechanism also would provide opportunities for discussion of the favorable impacts of project implementation on the local economy.

The Public Works Department may need to increase maintenance of the local road system during the construction phase. The envisioned level-of-effort should not affect adversely the economic viability of the project.

3.3.11 Land Use Issues

3.3.11.1 Ownership

Prior to implementation, Fergus Electric Cooperative will acquire all necessary easements to private or City of Lewistown lands.

3.3.11.2 Land Use Impacts

The hydropower generation site will be located within a "C-3" commercial zone. Properly designed and operated hydropower facilities are compatible with such a designation. The City-County Planning Board, in the course of issuing construction-operating permits, may stipulate various mitigating measures needed to ensure compliance with the (above) zoning regulations. Finally, restoration of park lands adjacent to, and minor landscaping (including security-type fencing) around the station and fishway could result in a tourist attraction. Thus, project implementation may have a positive effect on recreational opportunities by enhancing the game fisheries and providing an interesting energy generation facility.

3.3.11.3 Visual Resources

Any significant aesthetic impact discovered during project plan review will be evaluated for probable solutions. No great concerns are anticipated, as the project plan will recognize the need to:

- Locate and design the various facilities, as economically reasonable, to be absorbed into the surrounding landscape, (e.g., Western System Coordinating Council, 1971); and
- Design and implement successful sediment control and revegetation programs.

3.3.11.4 Cultural Resources

Once the decision is made to implement the project, a professional cultural resource inventory of the probably affected areas will be made (Section 3.4, MultiTech, 1983c). The inventory and data interpretation methodologies will be outlined in a Memorandum of Understanding, an agreement established between Fergus Electric Cooperative, the City of Lewistown, the Advisory Council on Historic Preservation, and the Montana State Historic Preservation Office (MSHPO). This document will assure compliance with pertinent federal and Montana statutes, etc., including identification of any necessary mitigating measures. Thus, if significant archaeologic, historic, or paleontologic sites are discovered on-site, the engineering design and operation plans will be evaluated for possible solutions. Furthermore, the MSHPO will be kept apprised of any such findings uncovered during the project's construction phase.

3.4 ENGINEERING-RELATED MITIGATING MEASURES

3.4.1 Centerline Selection and Final System Design

Upon a decision to proceed with the project, project engineers will survey locations of the generating station and fishway facilities. Information gleaned during these surveys will prove useful in site-specific design of facilities, particularly in identifying areas of concern (e.g., unstable slopes). Formal surveys (i.e., staking) of the facilities will proceed once approval of the preliminary locations has been received from the City of Lewistown.

The proposed design and construction methods will adhere to pertinent federal and Montana State laws and regulations regarding safety and reliability of the hydropower system. Such compliance will be assured by those agencies having review authority over this project.

3.4.2 Quality Control/Quality Assurance (QC/QA) During Construction

3.4.2.1 Generating System

The likelihood of hydropower system failure can be reduced through preparation of the construction planning document. This plan would be prepared following completion of the final engineering design and would include:

- The means of assuring that all penstock, power transmission, and power generating components comply with established performance standards (prior to use); and

- Protocols for evaluating the quality of the construction efforts, regarding the appropriate installation and proper functioning of the utility and power generation components.

3.4.2.2 Reclamation of Disturbed Areas

A general reclamation plan should be prepared that presents cost-effective means of slope stabilization, sedimentation control and revegetation at disturbed sites. This document would include plans for:

- Physical control of accelerated water erosion-sedimentation by such approaches as regrading, slope stabilization and construction of diversions for controlling run-off; and

- Biological control of wind and water erosion by appropriate preparation of the seedbed, planting an appropriate seed-forb mixture or installing sod, fertilizer, and follow-on maintenance prescriptions, etc.

3.4.3 Hydropower System Operating Plans

3.4.3.1 General Operating Plans

Detailed plans for the routine and emergency operation and maintenance of the hydropower and fishway systems must be postponed until the component designs are integrated in final form. However, the operating plan(s) will include the following:

- A description of the generating station's remote (electronic) measurement and control (and/or alarm) system, including redundancy necessary to increase (system) reliability;

- An approximate schedule for on-the-ground survey efforts to identify potential hazards to operation and maintenance of the hydropower and fishway systems; plus

- A description of how and when routine maintenance of the system will occur to ensure that everything is in working order. Such discussions will include: 1) testing and repair of power transmittal and generating equipment; 2) periodic (but selective) removal of debris accumulation within the various fishway systems; and 3) periodic control of weeds and erosion along the permanent access roads.

3.4.3.2 Emergency Operations Plan

A detailed plan for responding to emergency situations (e.g., major flooding occurrence) will be completed once the hydropower system design is finalized. In such instances, the primary objectives will be the protection of lives and property. The system would be repaired (as necessary) and returned to service only after human safety was ensured. The document will include such information as:

- Maps, system schematics, and various records needed to assure that the responsible personnel will determine the appropriate course of action (to a given emergency condition);

- The logistical means of coordinating emergency response procedures between the City of Lewistown, Fergus Electric Cooperative, Montana Power Company, and the USDA/Soil Conservation Service; plus

- Suggestions as to the probable number and location of personnel, equipment, etc., required to handle various emergency situations.

3.4.3.3 Hydropower System Decommissioning

Upon cessation of system operation, those materials of further value will be salvaged appropriately and then removed from the area. Unsalvageable materials will be disposed of in an approved waste-disposal area.

All sites where equipment or facilities are removed should be restored to some agreed-upon condition (via consultation with the particular landowner). The reclamation efforts envisioned are similar to those proposed for the construction phase.

4.0 LEGAL REQUIREMENTS

4.1 SITE OWNERSHIP

The MDC and associated right-of-way is owned by the City of Lewistown. Facility operation and maintenance practices must concur with agreements established with the USDA, Soil Conservation Service (USDA, SCS 1970b). Thus, the penstock installed between the diversion headgate and turbogenerator plant will be located on City property. Furthermore, such installation could be subject to stipulations placed upon it by the City, and possibly by the SCS.

The proposed turbogenerator site is located within Janeaux Addition Number One, Block Number 1, on lots numbered 1, 2, 11, and 12 (Mr. Earl Park, personal communication). The plant site is presently owned and maintained as a "mini-park" by the City of Lewistown (Figure 1-2).

4.2 WATER USAGE

The predominant water uses within the upper reaches of the watershed are for the maintenance of timber and range resources, including the concomitant fish and wildlife plus domestic livestock resources, regardless of land ownership. Ranch and farm operations scattered throughout these upper reaches consume water largely for domestic and livestock watering purposes.

In addition to forest and range resources, the topographically lower foothills and broader floodplains also support suburban residential tracts, commercial and Montana State fisheries operations, plus occasional irrigated farmlands (Fergus County et al., 1969; USDA Committee for Rural Development, ca. 1973). The irrigated lands produce grain (e.g., barley), alfalfa haylands, and pasturelands via subsurface, flood, or gravity sprinkler irrigation systems. In this foothills zone (near Heath, Montana) the U.S. Gypsum Company utilizes water for the mining and processing of gypsum ores.

Big Spring waters are utilized by the Montana DFWP's State Fish Hatchery and by the City of Lewistown. The Montana DFWP has filed water rights on 120 cfs from the confluence of Cottonwood Creek to the Hatchery pursuant to Chapter 345, Laws of 1969 (i.e., J. Murphy Rights). The City of Lewistown's municipal water supply is delivered through two steel transmission mains, one 16 inches in diameter and the other one 20 inches in diameter. The average rate of delivery ca. 1971 was 3,650,000 gallons per day with combined reservoir storage capacity of 1,350,000 gallons (Clark, Coleman, and Rupeiks, Inc., 1971).

4.3 EXISTING WATER RIGHTS

The Montana DNRC Water Rights Bureau's computerized record base indicated 133 claimed rights on the mainstem of Big Spring Creek, stretching from its headwaters to the confluence with the Judith River. If claimed rights on various unnamed tributaries are included, the number increases to 207. These recorded rights do not presently include those claimed by the USDA Forest Service (within the watershed). Further investigation yielded the following

mainstem water right claims within the watershed: Big Casino Creek, 25; East Fork Big Spring Creek from its source to confluence with Big Spring Creek, 46; Hanson Creek, 16; and Pike Creek, 13. No delimitor entitled "Upper Castle Creek" or "Castle Creek, Upper" could be located in the records (Mr. James Kindle, personal communication).

These decreed, filed, use, and "other" water right claims have been summarized for the Judith Basin as a whole, but not for its respective sub-basins. To compile a comprehensive description for the Big Spring Creek watershed, a number of "canned" computer programs would have to be utilized, as well as possible development of "customized" software as described in Milestone 2 Report. A section-by-section listing of surface water claims (within the defined area) can be generated. If judged necessary, the particulars of any given water right could be retrieved through searching the microfiche filing system. Ideally, special software should be developed that summarizes the total rate of flow and volume figures per type of use (for all uses) within the defined area of interest.

4.4 PLANNED FUTURE DEVELOPMENTS

In March 1980, the City of Lewistown applied to the DNRC Water Rights Bureau for reservation of an additional 7.6 cfs of discharge from Big Spring, pursuant to the provisions of 85-2-316, MCA (i.e., "Reservation of Waters"). It was stated in their application that presumed population growth would require such additional waters by 1990. Following interaction between the Department and City, the latter is currently reworking the analysis of population growth so

as to more rigorously address the statute's "statement of needs" criterion (i.e., subsection 3(b)).

Regardless of how this application for water reservation is resolved, it is not unreasonable to presume an increase in municipal water use (from present rates and quantities) over the next thirty to sixty years. The importance of the area's agricultural productivity to the State's economy and recognized "quality of life" should at least support a respectable future growth potential. For example, despite reported losses in population between 1960 and 1970, "new development and redevelopment did not cease" (Clark et al., 1971, p. 1). Furthermore, with an upgrading of rail and highway services, a modest level of industrial development, particularly in the vicinity of the airport, is possible.

Major expansion of irrigated land and water storage developments adjacent to the Big Spring Creek mainstem is not expected (USDA, SCS 1982 b, c). However, scattered tracts of less than 1000 acres or constituting less than 4000 acre-ft. of storage are possible. Clearly, continued opportunity exists for coordinated development of the subject area's water resources. The orderly development of water storage dams and reservoirs would provide water to overcome late season agricultural-related water shortages, a reliable water supply for new municipal and industrial developments, and enhanced water-based recreational opportunities.

The most speculative water uses relate to the mining and processing of the area's subbituminous coal and oil shale resources. The McDonald Creek basin, located within the Great Falls-Lewistown coal field, extends from Big Spring

Creek on the west to Forestgrove and Giltedge on the east (Calvert, 1909; Silverman and Harris, 1967). Recently, renewed interest has been expressed in developing the Heath and Tyler Formations for their petroliferous and nonfuel mineral values. As of March 1981, approximately 4900 acres of claims had been staked in Fergus County (Montana Standard news article). Given the decreased level of federal support for the technology(ies) and recent contraction of development efforts in the southwestern U.S., it appears likely that oil shale mining/beneficiation and extraction processes within Fergus County are decades away. Even more uncertain is whether or not such development would be affected by the previous withdrawl of water for other uses (including hydropower production).

In summary, increased usage of waters emanating from Big Spring(s) or from the watershed as a whole can be expected. The primary sources of new demand will originate primarily from the City of Lewistown and adjacent agricultural operations. However, in relation to the present study, the critical concern is the priority date of any new water appropriation(s). Obviously, if a given appropriation occurs after that water appropriated for hydropower generation, the former appropriation cannot deter water use for the latter purpose.

4.5 PROCEDURES TO ACQUIRE HYDROPOWER "FLOW RIGHTS"

Fergus Electric Cooperative recognizes that MDC-related hydropower production represents a new appropriation of water, and thus must apply for a use permit pursuant to 85-2-302, MCA. Prior to project implementation, an application for the "flow utilization right" will be prepared and submitted to the DNRC Water Rights Bureau. The key element in the application is the demonstration

of "clear and convincing" evidence that existing water users will not be harmed (Ms. Susan Higgins, personal communication).

Once the Department deems the application correct and complete, notice is served to pertinent public agencies and to those existing or potential appropriators affected possibly by the hydropower development (85-2-307, MCA). If valid objections to issuance of the permit are received by DNRC, public hearings to gather evidence will be arranged for and conducted (85-2-309, MCA). The hearings examiner then weighs the merits of the various arguments against his knowledge of water volume legally available for beneficial use. The application will be approved if it demonstrably satisfies the "criteria for issuance of permit" stated in 85-2311, MCA. The permit issued will be subject to any terms, conditions, restrictions, and limitations judged necessary to protect other appropriators.

Fergus Electric Cooperative presumes that, following conditional approval of its application by the Department, a provisional permit will be issued. In this fashion, construction can be completed in a timely manner, prior to receipt of final determination of water rights, with knowledge that vested rights to such water use exists (85-2-313, MCA). Once given the final determination of water right and after the water applied towards hydropower generation has occurred, Fergus Electric Cooperative will notify the Department that water appropriation has been completed. If the Department determines that such appropriation complies with the water use permit, a certificate of water right will be issued subject to the provisions of 85-2-315, MCA.

Presently, it does not appear as though any water rights have been claimed on the MDC (Mr. Sam Rodriguez, personal communication). Although the City of Lewistown owns the structure, it has not filed for water rights; this is presumably due to the intermittent nature of the flow and function of the MDC soley for flood control. As adequate instream flow reserves will be maintained for fish passage, etc., within both natural and artificial channels through Lewistown, the proposed hydropower development probably will be viewed by DNRC as being a non-consumptive, beneficial, use of water (Mr. Bob Lane, personal communication). Thus, it is in the Cooperative's best interest to establish as early a priority date (on water appropriation) as possible so as to avoid conflicts with other potential appropriators.

4.6 FEDERAL PERMITTING, LICENSING, AND PROJECT REVIEW AUTHORITY

4.6.1 Federal Energy Regulatory Commission (FERC)

The Fergus Electric Cooperative, Inc.'s (Fergus) proposal to develop the hydropower potential of the Mill Diversion Channel (MDC) will involve Federal Energy Regulatory Commission (FERC) licensing (or exemption from licensing) procedures. This assessment is based upon a review of the pertinent Code of Federal Regulations (CFR), and an unofficial opinion received from Mr. Witold J. Pawlikowski, staff engineer for the FERC's Chicago Office (phone conversation, January 3, 1983). The proposed development appears to satisfy the six criteria listed under "small conduit hydroelectric facility", as given in 18 CFR 4.91(f), (1)-(6).

At present, Fergus appears to have the option of either 1) applying initially to FERC for a preliminary permit (Permit); or 2) proceeding directly to exemption from licensing, as discussed under "Subpart J - Exemption of Small Conduit Hydroelectric Facilities" (18CFR 4.90-4.94). Although acquisition of a Permit is not required to obtain a license or an exemption from licensing, possession of the Permit can become important to a potential developer. The procedures for obtaining a Permit and Exemption from Licensing are discussed below.

4.6.1.1 Preliminary Permit Acquisition

The near-term acquisition of a Permit by Fergus (for the MDC site) is highly recommended for the following two reasons. Firstly, it will protect Fergus' priority to study the MDC site and prepare the presumed application for exemption from licensing, for a period of up to three years (after Permit approval). A Permit thus protects the considerable time and money invested in feasibility studies and license (exemption) preparation, because it can preclude simultaneous development by others. Secondly, with all other factors being equal, the earliest date for a series of competing applications will be given precedence by the FERC. A caveat associated with this second point is that: 1) the Federal Power Act gives preference to States and municipalities over private entities, provided the former has filed an equal application or can revise any previously filed application to make it technically equivalent to one filed by a non-public entity (16 U.S.C. 800(a)); and 2) under the Act, Rural Electric Cooperatives have the same status as private entities, (Corso, 1978). Therefore, if the City of Lewistown filed an approved application that is technically equivalent to one prepared by Fergus, the FERC

would award the Permit to the City, regardless of when the applications were filed. If the applications are not equal, the Commission would then issue the Permit to the applicant proposing a project that best fits the comprehensive development plan for the river basin, pursuant to Section 10(a) of the Federal Power Act.

The procedure for preparing a Permit application is described in detail in 18 CFR, Part 4, Subpart D, "Application for Preliminary Permit or License: General Provisions". Such application consists of an initial statement and four exhibits, and must present details regarding the proposed development to "the extent possible" (FERC, 1982, p. II-1). Clearly, the level of information expected by the FERC (and presented in the application) is proportional to the scope of the proposed hydropower development (18 CFR 4.30-4.30, 4.80-4.81).

The Washington Office can also find the application to be "deficient" or "patently deficient". In the former case, 45 days are given from date of notification for the applicant to correct the noted deficiencies and resubmit one original and 14 copies. Apparently, successful resubmittal of the application will not affect the priority date originally established by the FERC. In other words, the original date of submittal will be designated as the filing date. If the substantive requirements of 18 CFR 4.31 are not met, the application will be rejected out-of-hand. The applicant can resubmit the application, noting on its cover page the FERC project number, the word "REVISED", and date of revision. If the revised application is accepted by the FERC, the new filing date will be considered for purposes of determining the disposition of competing applications (as discussed under 18 CFR 4.33).

To avoid this "worst-case" situation, Fergus could seek advice from the Washington staff regarding the sufficiency of its application prior to formal submittal; in such case, five copies of the draft application must be sent to the Director, Division of Licensing Projects. All conferences with the FERC staff are subject to the requirements of Section 1.4(d) governing ex parte communications. Thus, "the opinions or advice of the staff will not bind the commission or any person delegated authority to act on its behalf" (18 CFR 4.31(g)).

Each applicant for a Permit must submit to the Secretary of the Commission (in Washington, D.C.) for filing an original and 14 copies of the application. The application may also include reduced prints of maps and drawings that conform to the specifications set in 18 CFR 4.32(d).

4.6.1.2 Exemption from FERC Licensing Procedures

Assuming that Fergus has obtained a Permit, an application for exemption from licensing can be filed during the term of the Permit with reasonable assurance that there will be no competing applicant. However, if Fergus proceeds to applying for such an exemption without prior acquisition of the Permit, there will be the same risks incurred as with a competing Permit application for the same site (Corso, 1978, p. 117).

Section 30 of the Federal Power Act authorizes the FERC to exempt small conduit hydroelectric facilities from all or portions of the Act's Part I licensing requirements expected for even "minor projects" (i.e., Short Form Licensing for projects of 5 MW_e or less capacity). The proposal by Fergus

to develop the hydropower potential of the MDC appears to fall under this section of the Act, as it satisfies the exemption criteria stated in 18 CFR 4.91(f).

An application for exemption will be processed in accordance with the procedure discussed in 18 CFR 4.31(c) through (g), except that notice of filing will be published only once in the Lewistown News-Argus. The additional time allowed for correcting deficiencies in an application may not exceed 45 days. The Commission may order a hearing on an application either on its own motion or the motion of some other interested party. Any such hearing will be limited to the issues prescribed by order of the FERC. Under the Regulations, the Commission must exercise one of the following actions within 90 days of notifying the applicant that an acceptable application has been this time period: 1) granting the exemptions as requested; 2) granting an exemption from provisions of Part I of the Act other than those for which exemption was requested; and 3) deny exemption, upon finding such application is inconsistent with Part I of the Act, "or is otherwise inconsistent with the public interest" (18 CFR 4.67(d) (3)).

FERC can suspend the 90-day period upon finding that additional time is necessary for proper review and deliberation over the application. Any exemption granted by the FERC is at least subject to the standard terms and conditions presented in 18 CFR 4.67(f)(1)-(3); potential stipulations regarding protection of other water resource values, etc., are discussed in 18 CFR 4.67(g). Finally, any fish and wildlife agency that does not comment within 45 days from issuance of the notice of application will be presumed to have no objection to the exemption requested. This implies an acceptance of those terms

and conditions specified by the FERC other than those possibly included in Exhibit A of the application for exemption.

4.6.2 U.S. Army Corps of Engineers (ACE)

4.6.2.1 The "Section 404" ("Dredge and Fill") Permit

The U.S. Army Corps of Engineers has jurisdiction over any project which is proposed for a navigable waterway (as authorized under Section 10 of the amended Rivers and Harbors Act of 1899, 30 Stat. 1152 et seq.), or which involves the discharge of any dredge or fill material into navigable waters of the U.S. (U.S. Corps of Engineers, 1977). For practical purposes, a "navigable water" is one, "which by itself or by uniting with other waters forms a continued highway over which commerce may be carried on with other states or countries" (Black, 1979, p. 926). A more comprehensive discussion of this term is found in 33 CFR 329, ("Definition of Navigable Waters of the United States").

In the dredge and fill case, the Corps can exercise the authority given it in Section 404 of the Federal Water Pollution Control Act (86 Stat. 884), as ammended in 1977, to determine whether a permit must be issued to comply with the Act. If such a permit is deemed necessary, it must be prepared in addition to any FERC licensing or EPA review procedures (33 CFR 320.2(g)).

The EPA concurs with the issuance of the Section 404 permit if the proposed discharge of dredged and/or fill materials meets the applicable restrictions set in 40 CFR 230.10; such permit review authority is discussed in detail in

40 CFR 230.7 ("General Permits"). In general, a written determination is made that documents potential short-term and long-term effects of a proposed discharge on the physical, chemical, and biological components of the affected aquatic environment. These findings are utilized in determining compliance with the restrictions found in subparts C through F of 40 CFR 230.10.

4.6.2.2 The "Section 10" Permit

Section 10 of the Rivers and Harbors Act (also cited as 33 U.S.C. 403) prohibits the unauthorized obstruction or alteration of any navigable water of the United States. In general, the Corps does not require a separate Section 10 permit in those cases where the FERC exercises licensing jurisdiction. The Corps does, however, review and comment on applications received by the FERC as part of the Commission's pre-license consultation to ensure protection of navigational interests. The applicability of this permit to the Fergus/MDC project awaits a formal decree by Federal and Montana State authorities as to whether the MDC is indeed "navigable".

The above permit applications are made on an ENG Form 4345 and require approximately three to six months for review and approval (Cunningham, 1982). The form requests information on the nature and location of the proposed activity, the time span involved, and the status of other federal, state, and local permitting procedures.

Upon receipt of the application, the Missouri River Division issues public notice and requests comment (33 CFR 209; 40 FR 31319). The FERC license, or exemption from licensing, should already be on file at the time of Corps

review. After 30 days of publication, the involved agencies may either respond with approval, request a public hearing, or request a hold be placed on the review process. Comments are also requested from local, county, and Montana state agencies. The permit is issued following receipt of all agency approvals by the Corps.

4.6.3 U.S. Department of Interior (USDI)

4.6.3.1 Fish and Wildlife Service (FWS)

Even if there are no competing applications, a hearing may be required if there is opposition to the project design or its proposed operation. In general, the most probable objections are related to water quality and fishery issues, particularly where fish facilities (e.g., fish ladders) may be required (Corso, 1978). Thus, Fergus will consult with the FWS (and Montana Fish, Wildlife, and Parks Department), especially regarding to the provision of funds and/or technical assistance to implement such facilities, if stipulated in the FERC exemption from licensing document. The principal statutes giving the FWS review authority over small hydroelectric facilities are discussed below.

The Fish and Wildlife Coordination Act, (16 U.S.C. 661 et seq; as amended), requires the FERC to consult and cooperate with Federal and State fish and game agencies. The Commission assures this cooperation, especially for major projects at existing dams or unconstructed major projects greater than 5 MW_e installed capacity, via materials included in Exhibit "E" (i.e., data previously prepared for Exhibit "S") of the FERC license application. This

exhibit includes the developer's plan, prepared under guidance and assistance from the pertinent agencies (see also 50 CFR 81, "Conservation of Endangered and Threatened Species of Fish, Wildlife, and Plants - Cooperation with the States").

Fergus could remove from Exhibit "E" (of the exemption application), any discussion on mitigating measures related to fisheries; the discussion would be placed in an Exhibit "S". In this fashion, any disagreement on the adequacy of the fish management plan can be isolated quickly from other environmental matters relegated to Exhibit "E". If such disagreements occur, the FERC must resolve the differences through: 1) informal conferences; 2) further correspondence between the FERC and the involved parties; and 3) formal hearings. Clearly, the greatest concern arises from the possible requirement for construction of expensive fish facilities; such a requirement could preclude economic viability of the proposed development.

The Threatened and Endangered Species Act (16 U.S.C. 1531-1543; as amended), requires Federal agencies to ensure that actions they authorize, implement, etc., do not jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy the "critical habitat" of such species. Although certain animal species present in Montana have been designated as threatened or endangered, corresponding "critical habitat(s)" have not been demarcated by the USDI.

The FERC will contact the pertinent FWS office and request an opinion be rendered on whether or not a biological assessment is needed for a given project. Such consultation is done pursuant to Section 7 of the Act (i.e.,

16 U.S.C. 1536). Once the inquiry is received by the Regional Director's Office in Denver, the FWS must respond within 30 days of receipt of the inquiry with a listing of species that may be present within the designated study area (50 CFR 402.04 et seq.). If the FWS indicates that known threatened and/or endangered species, or species proposed for Federal listing, may occur in the project area, a biological assessment must be conducted within 180 days after initiation of the FWS assessment. The methodologic details of this assessment can be found in the U.S. Department of Interior's FWS 1979 Memorandum to Regional Directors. Subject: Section 7, Consultations with Attachments (Washington, D.C.).

4.6.3.2 Advisory Council on Historic Preservation (ACHP)

Before the FERC can issue a license, the Advisory Council on Historic Preservation and the State Historic Preservation Officer (SHPO), must be consulted to assure that no historic or cultural site or landmark district will be adversely affected by the proposed development (36 CFR 61.8). Thus, the developer must comply with the intent of the Historic Preservation Act, 16 U.S.C. 470, as amended; and Executive Order No. 11593, "Protection and Enhancement of the Cultural Environment (36 FR 8921, May 13, 1971).

Applications for the small conduit or case-specific exemption from licensing must list any sites eligible for, or included in, the National Register of Historic Places (Register). In addition to prelicensing consultations with the ACHP and National Park Service (NPS), the applicant may obtain assistance in the preparation of this information from the SHPO (re: 18 CFR 4.92(c)(5) and 18 CFR 107(e)(1)). The procedures utilized in determining whether a given

project will exert "no effect", "no adverse effect", or an "adverse effect" and subsequent regulatory actions required is discussed in 36 CFR 800, "Protection of Historic and Cultural Properties".

An application for generic exemption for projects greater than 100 kW_e must include certification (to the FERC) that the SHPO has determined that the proposed small hydroelectric power project will not adversely affect any site included in, or eligible for inclusion in, the Register.

4.6.4 U.S. Environmental Protection Agency (EPA)

Pursuant to Section 401 of the Federal Water Pollution Control Act Amendments of 1972 (86 Stat. 877), applicants for a Federal license to construct and operate a hydroelectric facility are required to obtain a State water quality certification that any discharge from the proposed project will comply with applicable provisions of the Act. Applications for license must include as an appendix to Exhibit "E" one of the following: 1) a copy of the water quality certificate received from the state water quality bureau; 2) an agency statement that such certification is waived; or 3) a copy of a dated letter from the applicant to the appropriate agency requesting such certification (U.S. FERC, 1982, p. A-36).

The U.S. EPA has delegated its Section 401 certification responsibilities in Montana to the Department of Health and Environmental Sciences (DHES), Water Quality Bureau (WQB). The WQB will review the water resource data and analysis contained in the "401" application to evaluate the probability of success of the development in complying with State water quality criteria. Such

compliance is usually done by imposing minimum flow requirements, which in fact are usually included as license requirements by FERC (Corso, 1978). If the Fergus/MDC project receives a case-specific exemption (e.g., under the small conduit case), a Section 401 certification will not be required. Application for a NPDES Permit, pursuant to Section 402 of the Act, will not be necessary, because no recreation facilities or other facilities requiring sewage treatment are included in the MDC hydropower development plan.

4.6.5 U.S. Federal Aviation Administration (FAA)

The U.S. FAA has statutory authority to assess whether or not a proposed development will affect navigable air space, as set forth in Part 77 of the FAA Regulations (14 CFR 77, "Objects Affecting Navigable Airspace"). This part delineates those conditions under which a construction or alteration project will require official notification to the FAA Regional Administrator, and subsequent permit application proceedings. Section 77.23 of the Regulations establishes standards which define an obstruction to air navigation.

As presently envisioned, project design will not in any way affect navigable air space. Thus, those criteria discussed in Section 77.15 now become applicable (i.e., "Construction or alternation not requiring notice").

4.7 ADDITIONAL FEDERAL ACTIONS AND CONSIDERATIONS PERTINENT TO SMALL-CAPACITY HYDROPOWER PROJECTS

4.7.1 Access to Federal Lands

If the applicant seeks a preliminary permit or license (pursuant to the Federal Power Act), and if any part of the project is located on National Forest Service (FS) lands, a "Memorandum of Understanding" or special use authorization must be established between the particular Forest Supervisor's Office and the applicant. Such authority is discussed in 43 USC 931-975(g) and 43 USC 1701-1782. This authorization allows for project studies and investigations on FS lands, but does not authorize construction (Cunningham, 1982). Because the review process requires approximately three months, a preliminary approval should be obtained from the USFS during the design phase of the project. Some reimbursement may be required (re: Section 10E of the Federal Power Act). The types of information to be provided are discussed in 43 CFR 2800, "Right-of-Way, Principles and Procedures".

Similar procedures must be followed if portions of a project will occupy permanently USDI Bureau of Land Management (BLM) property. In such a case, the developer must acquire a "Right-of-Way Authorization" from the local BLM office; this authorization includes a negotiated rental agreement, based on current land values, between the BLM and applicant. "Temporary Use Permits" and "Construction Materials Sales" permits are also available (Cunningham, 1982).

4.7.2 Other Federal Agencies Potentially Involved in Project Review

4.7.2.1 The U.S. Department of Commerce, NOAA, National Marine Fisheries Service (NMFS)

The NMFS may be consulted by the USFWS and/or by the Montana Department of Fish, Wildlife, and Parks (DFWP) regarding the design, construction, and operation of fish facilities. However, as there are no anadromuns ("ocean-going") fish species present within the study area, it is unlikely that the NMFS will participate directly in the permitting/licensing procedures.

4.7.2.2 USDI Office of Environmental Project Review (OEPR)

Upon receipt of application for preliminary permit, or application for exemption from licensing if no preliminary permit was applied for, FERC will request USDI commentary through the OEPR in Washington, D.C. The OEPR will in turn request field-level office review of the Notice of Application, as viewed from each agency's particular jurisdiction or special expertise. In addition to the FWS, other agencies participating in the review process could include the Bureaus of Reclamation, Indian Affairs, and Mines plus the National Park Service. These reviews will assure minimal interference with any present or potential water development and/or mineral development occurring in the project area, as well as not interfering with the activities of the National Park Service, if applicable.

4.8 MONTANA STATE PERMITTING, LICENSING, AND PROJECT REVIEW AUTHORITY

Although the Federal Government excercises final jurisdiction over hydropower generation, state and local agencies also require certain agreements and project approvals. Some of these permitting documents are provided cojointly with Federal approval(s), while others are obtained separately. The principal Montana State agencies involved in the hydropower permitting process are described below.

4.8.1 Department of Natural Resources and Conservation (DNRC)

4.8.1.1 Water Right Permit

A water right permit to use water for hydropower generation is required in all cases where surface water will be used, or if a ground-water source with a maximum appropriation of 100 gpm or more will be used (85-2-301 et seq., MCA). In the Fergus-MDC case, only surface flow will be utilized; thus Form No. 602 (Notice of Completion of Groundwater Development) will not be required.

Fergus will acquire and complete the Beneficial Water Use Permit application, Form No. 600; this form can be acquired from the Water Rights Bureau field office in Lewistown (re: 85-2-307 through 317, MCA; 36.12.102, ARM).

The Bureau also requires the applicant to meet a certain burden of proof for specific criteria, before the permit can be issued.

4.8.1.2 The "310" Permit

To obtain a "310" permit, Fergus must comply with the provisions set forth in the Natural Streambed and Land Preservation Act of 1975 (75-7-101 et seq., MCA; see related statutes in 76-15, 76-16 MCA pertaining to soil-water conservation and grazing conservation districts).

4.8.1.3 Flood Plain Development Permit

In most cases, the location of a small-capacity hydropower facility within designated boundaries of the 100-year flood plain will require a Flood Plain Development Permit. In addition, the developer may have to prepare and submit a request to establish or alter an existing floodplain obstruction or implement some nonconforming use of the floodplain. A visual estimate of the 100-year floodway and flood fringe areas remaining after implementation of the Big Spring Creek watershed plan (USDA, SCS, 1980; Photomaps 11 and 12) indicates an areal extent of about 10.5 acres. This area is located upstream of the diversion headworks, and is generally outside of the Fergus-MDC project area. It is the informal opinion of Mr. John Hamill of the DNRC's Engineering Bureau, Floodplain Management Section that the former permit will be necessary in the case of Fergus-MDC development (personal communication, January 20, 1983).

4.8.2 Department of Fish, Wildlife, and Parks (DFWP)

Although the Montana DFWP does not have permitting authority per se, they are entrusted with extensive review authority pursuant to 87-5-501 et seq., MCA.

Consequently, the Department excercises a major role in determining the eligibility of the applicant to receive other necessary permits, including the FERC license or exemption from licensing (Cunningham, 1982). The environmental concerns addressed by the DFWP include: 1) causation of stream flow fluctuations on a daily basis or modification of an existing flow regime on a seasonal basis; 2) causation of changes in water-quality parameters (e.g., temperature) due to the location and/or physical means of water withdrawal and/or discharge; 3) impacts associated with changes in reservoir operating practices, e.g., increased late fall/early winter (reservoir) drawdown; 4) impacts associated with power transmission line siting, construction, and operation; 5) impacts to the streambed and/or streambank, plus associated riparian habitat, arising from power plant construction and operation; 6) causation of accelerated streambank erosion upstream or downstream of the hydroelectric site; and 7) frequency and extent of future repairs and maintenance envisioned by the developer, (Cunningham, 1982).

Mr. Larry Peterman, Water Resources Supervisor for the MDFWP (Helena) has been kept informed regarding preliminary design and operation of the MDC facility. Particular emphasis was placed on the design, construction, and maintenance of fish ladders, as detailed in Montana statute (i.e., 87-1-222, MCA) and associated rules (i.e., ARM 12.7.401). Information acquired from the Department (and from the USFWS) was integrated into the Milestone 4 (Engineering Design) and Milestone 6 (Environmental Report, "Exhibit E").

4.8.3 Department of Health and Environmental Sciences (DHES), Water Quality Bureau

4.8.3.1 "Section 401" Water Quality Certification

The State of Montana has promulgated a listing of surface water quality standards (ARM 16.20.601 through 16.20.643), pursuant to the Montana Water Quality Control Act (75-5-101, et seq., MCA). Each stream segment or basin in the state has been classified in accordance with existing or desired water quality and use. For example, the mainstem of Big Spring Creek from the MDC headgate downstream to the Judith River is classified as B-2.

As alluded to in Section 4.6.4 (USEPA), the Federal Water Pollution Control Act (33 USC 1251 et seq.) is applicable to those FERC-licensable projects that will result in a discharge into navigable waters. The strategy for acquiring exemption from licensing does not preclude compliance with this Act if such a discharge occurs. Furthermore, the application for a 401 Certificate is issued through the MDHES (Helena, Montana); such issuance can be dependent upon other water quality-related permits and approvals (e.g., the MPDES permitting review, ARM 16-20-901 through 919; see subsection 3.3.3).

Information requirements vary significantly with the complexity of the project (Harrison, 1982). The necessary application form can be obtained from the WQB. As the information presented can range from identification of the developer, project location, etc., to detailed environmental and engineering studies, a pre-application meeting with MDHES is advisable.

4.8.3.2 Authorization for Short-Term Exemption from the Turbidity (Water Quality) Standard

This authorization is applicable to those situations involving instream activities associated with road, bridge, or other forms of construction. This requirement can be waived if Fergus obtains a "310 Permit" from the local conservation district and the Montana DFWP does not specifically require the Authorization.

This Authorization is a conditional exemption from turbidity standards, pursuant to the Montana Water Quality Act (75-5-101 et seq., MCA) and associated rules (i.e., 16.20.633(3)(a), ARM). Its purpose is to regulate necessary, short-term, and unavoidable violation of Montana State's turbidity standard, despite application of best engineering/construction practices. Thus, if the DHES determines that such activities will increase Big Spring Creek's naturally occurring turbidity by more than 10 nephelometric turbidity units, such an authorization will be required.

The pertinent form, entitled "Application for Short-Term Exemption from Surface Water Quality Standards for Construction Activity", may be obtained from the DHES, Helena. After the review and inspection, the authorization is either issued or denied. The Authorization issued by the Department will stipulate conditions under which the applicant must operate during the period of violating the turbidity standard.

4.8.3.3 The "MPDES" Permit

The Montana Pollutant Discharge Elimination System (MPDES) permit is required for all development activities producing a point-source wastewater discharge. The permit requirements include those cases related to cofferdam construction or other construction dewatering discharges. As this may occur during the Fergus-MDC project, the WQB will probably require the issuance of a general MPDES permit pursuant to ARM 16.20.914. In such a case, Fergus would complete the "Short Form C" application form.

4.8.3.4 The "310" Permit

The DHES may also participate when proposed projects are reviewed for issuance of the 310 Permit by the DNRC, Conservation District (Cunningham, 1982).

4.8.4 Montana State Historic Preservation Office (SHPO)

Hydroelectric development occurring in Montana must comply with Federal and State requirements for the protection of cultural resources. The Montana Historical Society's Historic Preservation Office (SHPO) administers the Montana Antiquities Act permitting process, as it relates to State and Federal cultural resource laws and regulations (Montana Antiquities Act, 22-3-401 through 442, MCA; National Historic Preservation Act of 1966, as amended in 1980, 16 U.S.C. 470); and Federal compliance with 36 CFR 800). Any project requiring, among other things, a license by the FERC, will require the participation of the SHPO regardless of land ownership. In reviewing Federal

actions, the Society comments for the State, but does not grant final clearance (Harrison, 1982). The Montana Antiquities Act, revised in 1979, pertains to "state actions or state assisted or licensed action". The Act requires that heritage properties (i.e., significant historic, archaeological, and architectural properties) and paleontological remains situated on State lands be identified and protected (Cunningham, 1982). As none of the land area present within the study area is owned by the State of Montana (excepting the stream bottom up to the "high-water line"), the application of the Antiquities Act requirements to the Fergus project is probably advisory rather than substantive (Mr. Lon Johnson, personal contact). Procedures for complying with the Antiquities Act are detailed in the Milestone 5 Report.

4.8.5 Potential Involvement by Other State Agencies

The Montana Department of State Lands (DSL) and Highways (DOH) also may have permitting authority over this project. If Big Spring Creek is designated a navigable waterway, DSL must issue a permit for right-of-way. Likewise, if construction or the power generator facility itself encroaches on the right-of-way for Montana Highway 87, DOH will exercise permitting authority. The details of these two permits are presented in the Milestone 5 Report; most likely, the permits will be unnecessary.

4.9 LOCAL PERMITTING PROCESS AND REVIEW AUTHORITY

All county and city permit requirements must be satisfied prior to, or concurrently with, application to the FERC for license (or exemption from licensing), as well as for use and occupancy of Federal land(s), if applicable, (Harrison, 1982).

4.9.1 Fergus County-Related Permitting Requirements

The proposed hydroelectric facility and appurtenances will be designed for, and operated in, an automated mode. The presence of human activities will be limited to periodic inspection/maintenance and emergency repair efforts only. Thus, provisions for on-site potable water supply and systems for sewage and solid waste disposal will be of a minimal nature. However, Montana and local departments of health will have review authority over the designs proposed for these systems, and should be consulted as the study progresses. Furthermore, no local requirements pertaining to air and water quality standards exist (Harrison, 1982).

The Fergus County Conservation District (in Lewistown) is involved in approving applications for altering the streambed and/or immediate banks of natural perennial streams. Whether this permitting process applies to the MDC remains uncertain (Mr. John Hughes, personal communication). However, the area immediately upstream of the diversion headworks has been demarcated as being within the 100-year floodway or flood fringe for Big Spring Creek (USDA, 1980; Photomap Nos. 11 and 12). Thus, any modifications to the headworks to accommodate hydropower production must be permitted by the County Planning Board (with prior DNRC approval); such modifications cannot raise the calculated elevation of the 100-year flood by more than 0.5 foot.

The Fergus County Commissioners adopted county-wide flood plain regulations on March 10, 1978, pursuant to Montana Flood Plain Law (76-5-101, et seq., MCA). These regulations apply to those areas occasionally flooded despite the presence of the upstream dams and MDC. In addition, Fergus County then entered

into the National Flood Insurance Program (i.e., the Emergency Program) on April 13, 1978. Fergus Electric Cooperative will review the above regulations and flood insurance requirements prior to finalizing proposed design of the project facilities.

4.9.2 City of Lewistown-Related Permitting Requirements

At present, the proposed turbogenerator station will be located near the southwest corner of the Main Street Bridge, and northwest of the MDC's drop structure. This area has been designated by the City as being a "C-3" commercial zone; if properly designed and operated, hydropower facilities are compatible with such a designation, as they are "utilities serving the public good" (John Hughes, personal communication). To ensure compliance, Fergus Electric will have to present their plans, etc., before the Planning Board via a public hearing; once given formal approval by the Board and by the City, Fergus can proceed with the project.

The City of Lewistown is certified to administer the Universal Building Code, plus mechanical and energy codes, etc. However, field inspectors from the Montana Department of Administration will check for compliance with the Universal Electrical and Plumbing Codes (Mr. Ron Hetrick, personal communication). At the time of applying for such permits, the master electrician and plumber responsible for overseeing construction activities will attest to compliance with these codes. Finally, the City Public Works Department must be informed of any modifications of traffic flow within the construction site vicinity; this is particularly important in regards to safe operation of emergency vehicles in and adjacent to the construction area.

APPENDIX -- INFORMATION SOURCES

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